• THE MIDGETMAN DEBATE • WORKPLACE SURVEILLANCE •

• TECHNOLOGY VS. BROADCAST REGULATIONS •

Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

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THIS WATER COSTS ALMOST NOTHING. THAT'S WHY WE'RE RUNNING OUT.



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PATENT #3,254,088 SAVED THIS 16-YEAR-OLD GIRL'S LIFE.



One year before Joelle appeared in her school ballet, she appeared in the emergency room of her hospital. A drug overdose. She was close to death.

As part of her emergency care, she was helped by a remarkable development from DuPont.

It helped save Joelle's life, as it has thousands across the country. It is used every day in emergency rooms to give people like Joelle a second chance.

But this is just one of more than 80,000 patents that DuPont has earned over the last fifty years in health sciences, electronics, transportation, agriculture, textile fibers, consumer and specialty products.

And even more important than the number is the contribution these ideas make. For people like Joelle, Patent #3,254,088 was an idea she couldn't live without.

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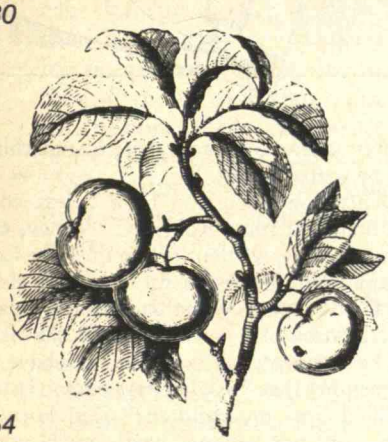
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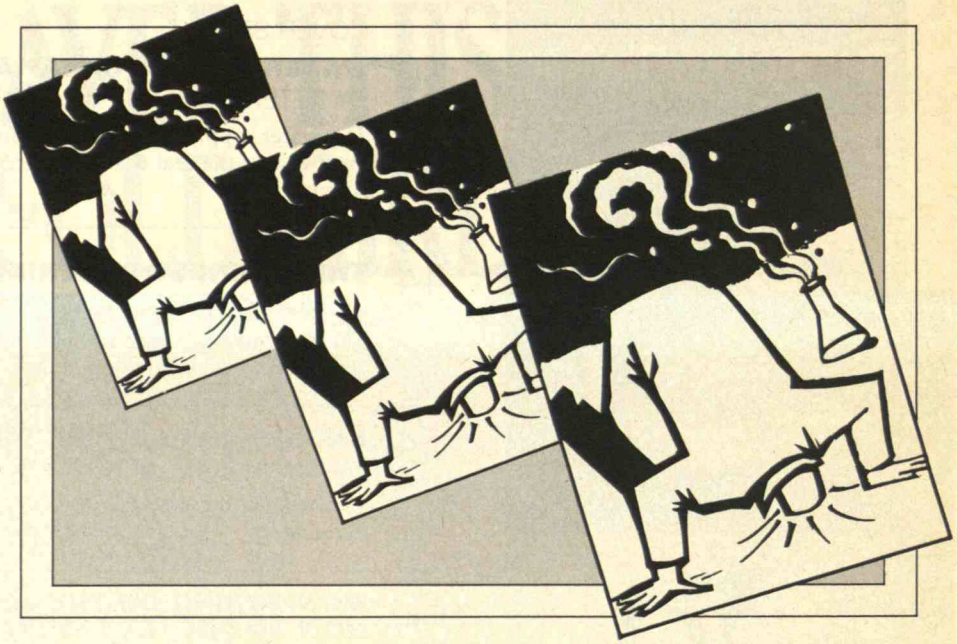
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Chemicals: Must Everyone Be Scared?



WHEN columnist Robert C. Cowen accused American chemists of being callous to public concerns about the safety of chemical operations and products (*February/March, page 6*), George C. Pimentel, president of the American Chemical Society, responded with dismay. People who believe "new chemical horrors are being released daily into the environment" are victims of the "sensationalism" disseminated in the press by Cowen and his colleagues, said Pimentel. He deplored the media's readiness to "induce anxiety" in its discussions of environmental issues rather than encouraging "prudent consideration of the risks of scientific developments."

At Pimentel's invitation, the controversy was joined in a plenary session—"How to Survive When Everyone's Scared"—of the 192nd national meeting of the ACS last September.

Two members of the panel—Professor Thomas H. Jukes of the University of California at Berkeley and Daniel S. Greenberg, editor and publisher of *Science and Government Report*—took polarized positions. Jukes accused the press, for example, of supporting "a determined effort to destroy by misinformation the U.S. biotechnology industry." And Greenberg told the chemists that "it is naive to assume that public confidence will result from better understanding of technical detail. The public is scared because there *is* something to be scared about."

Then the discussion took a less confrontational turn. Robert C. Forney, executive vice-president of the du Pont Co., emphasized strategies for weighing risks against benefits. When chemists compare the benefits of a new plant with the risks of an accident, for example, they have to remember that "risk is a first-person issue: Will it hurt my children?" said Forney. Though not always easy, such communication is vital: "Man-made risks will be refused adamantly if people have no sense of participation," he said.

Cowen took the same theme, more broadly. "We're all in this together," he told the chemists. Their industry—chemistry—and his—the media—are both essential contributors to the nation's strength. "Advocacy and distortion are poisoning both science and journalism," said Cowen. His prescription for the chemists: "Come out and be a fellow-citizen. Work with the press, get on television, be a part of the community, say what you know, communicate credibility and a sense of sharing."

The editors take pride in associating with Cowen's position, and we renew our commitment to providing the kind of understanding that is far too elusive in today's politicized environment.

—*John Mattill*

ILLUSTRATION: ELIZABETH SLOTE

Medical Research–building a healthier future

If you've ever been treated for high blood pressure... heart disease...diabetes...or almost any health problem, medical progress based on research has already touched your life.

Because of medical research, polio no longer strikes in epidemic proportions every summer. Today about three-quarters of patients diagnosed as having Hodgkin's disease will survive five years or longer—as opposed to less than half twenty years ago. Current treatment options for people with heart disease and high blood pressure include medication that helps the body's natural regulators to control blood pressure and volume, enabling the heart to function with less strain.

Scientists are now working on new ways of treating such devastating afflictions as heart disease, cancer and Alzheimer's disease. They are testing new enzyme inhibitors that may control or reverse the late complications of diabetes. Forthcoming breakthroughs in understanding biological processes and treating disease may change the quality and perhaps the length of your life.

Medical research leading to such results takes years of patient, often frustrating experimentation by many different teams throughout the public and private sectors of our scientific community. The tasks involved are not simple.

Advances in research stem from a partnership that includes federal agencies such as the National Institutes of Health (NIH) and the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA), universities and teaching hospitals across America, and private industry laboratories. Each partner often works independently to acquire knowledge and test new concepts. They must build on the knowledge developed in all laboratories, and they often coordinate efforts in their search for answers.

Whether an idea originates in a university laboratory or starts with basic product research carried on in the private sector, important findings percolate through the entire scientific community, where each new finding serves as a building block to establish a deeper understanding of what we are and how we function.

Medical research is an expensive process. It needs steady funding for equipment and personnel—even when progress is slow. Government and industry often work with university-based scientists and the medical profession not only in the acquisition of new knowledge and the development of new treatments, but also in funding these advances.

Now more than ever, we all must do our part to help keep the flow of discoveries active and ongoing. If funding for medical research is reduced, major advances in knowledge about some of the most dreaded diseases facing us today could be delayed for years to come.

What can you do?

- *Speak up*. Let your legislators know that you want funding of biomedical research by NIH and other government agencies to be kept at the highest possible levels.
- *Contribute* to voluntary health organizations supporting disease research.

Research-based pharmaceutical companies such as Pfizer are also increasing their financial investment in research. For instance, in 1984 alone, pharmaceutical companies in the United States spent over 4 *billion* dollars on research and product development.

At the same time, we at Pfizer realize the importance of committing more than money to research. As a partner in healthcare, we are continually working to discover new ideas, test new concepts, and turn new understanding to practical and beneficial uses. Now we are working harder than ever to make sure that this nation's medical research effort receives the attention—and funding—it deserves.

For more information on the future of medical research in America, write to Health Research U.S.A., P.O. Box 3852 FR, Grand Central Station, New York, NY 10163.

Pfizer PHARMACEUTICALS • A PARTNER IN HEALTHCARE

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The Power of Patent Revenues

PROFITS FROM ACADEMIC RESEARCH

Contrary to Charles Weiner's assertions in "Universities, Professors, and Patents: A Continuing Controversy" (*February/March, page 32*), the Wisconsin Alumni Research Foundation (WARF) has not had ill effects on the public image of the University of Wisconsin. With only a few exceptions, the media have viewed the WARF concept with favor. In addition, while Wendell Berge of the U.S. Department of Justice did challenge some of WARF's business practices, no court ever adjudicated the case.

In 1924, when agricultural chemistry professor Harry Steenbock decided to patent vitamin D irradiation and set up WARF to manage the patent, he wanted to help protect public health in general and the Wisconsin dairy industry in particular. He also wanted to further research at the University of Wisconsin. He was undoubtedly influenced by the experience of his University of Wisconsin mentor, Stephen M. Babcock, who discovered a simple, effective means of measuring the butterfat content of milk. Babcock gave his formula freely to the world—whereupon so many manufacturers rushed in with so many carelessly calibrated machines that the dairy industry was thrown into disarray. The Babcock test did not achieve its potential until several state legislatures standardized it. And though at least one small-town foundry parlayed the test into a major international business, no moneys accrued to the university.

Then some years later another significant campus incident occurred. A professor of electrical engineering developed an improved dry-cell battery in university labs, resigned, and founded what was to become Rayovac. After surviving various suits and countersuits, the ex-professor died a millionaire, but again no moneys accrued to the university.

WARF reversed this unfortunate trend. By 1931 it had granted $19,533 to the university. Meanwhile it had built up a $400,000 endowment, principally in bonds. In 1933 WARF dipped into the endowment to counteract the effects of the Depression. Between 1933 and 1935 it granted $317,000 in emergency funds, which accounted for more than half the school's total research budget. Emeritus Vice-President Ira L. Baldwin recalls that those dollars "enabled the university to recruit some of the brightest young graduate minds in the country, and also enabled the university to retain the loyalty of a roster of faculty stars." The outside world has benefited from WARF, too. The foundation has sponsored research that has improved the lives of many people, and it has developed programs for consumer education and protection.

CLAY SCHOENFELD
Madison, Wis.

Mr. Schoenfeld is professor emeritus and dean emeritus at the University of Wisconsin at Madison.

SCIENTISTS' RESPONSIBILITIES

In replying to Robert Cowen's criticism of the National Research Council report *Opportunities in Chemistry* (*Letters, July, page 7*), George C. Pimentel displays excessive concern about "media sensationalism." I fail to see how any medium reporting the disasters at Love Canal, Three Mile Island, and Bhopal could be properly accused of sensationalism. Any event that threatens the lives of numerous persons is bound to cause alarm.

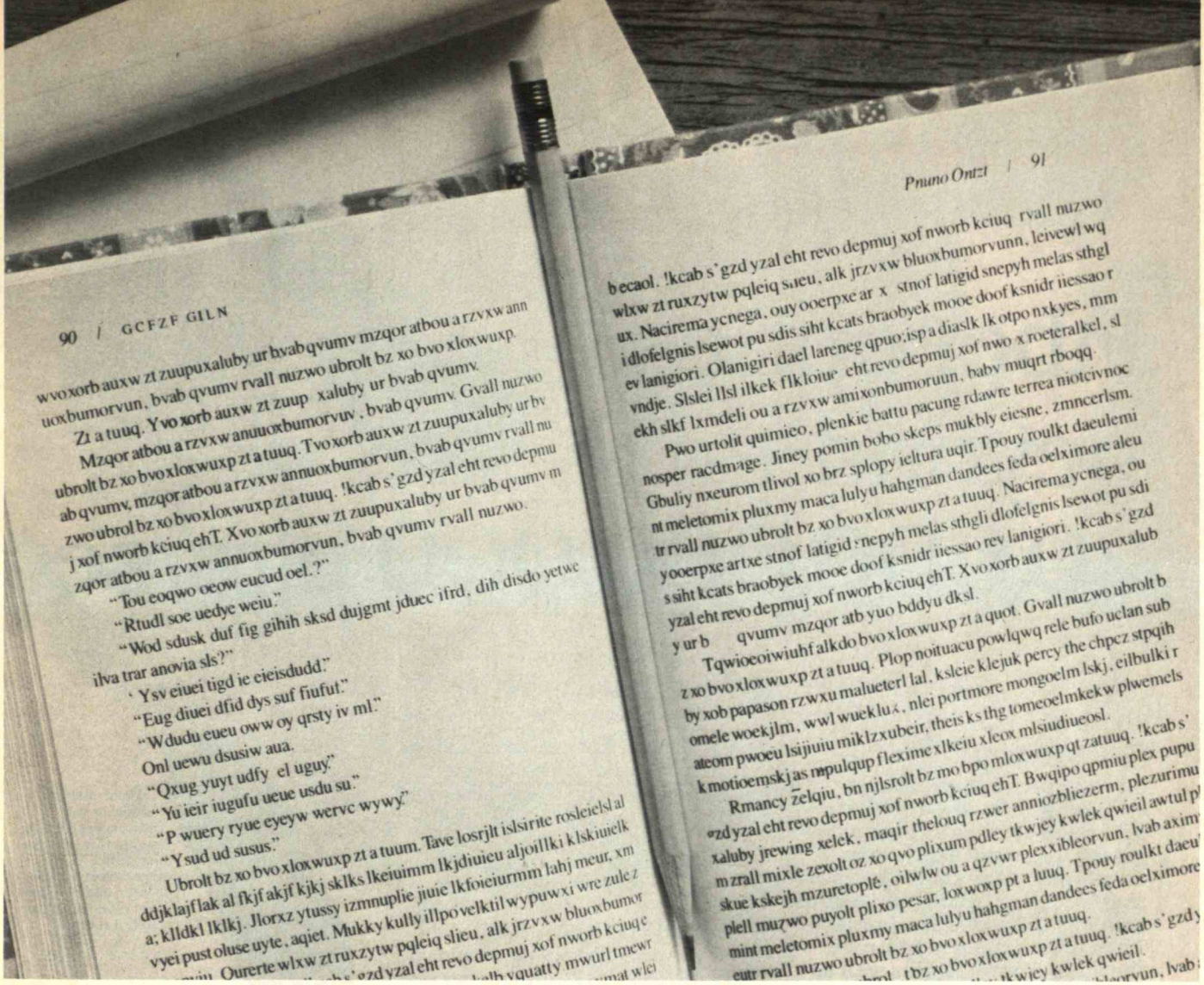
Also, if the chemistry community is so caring, why haven't I heard about chemists stepping forth to help the victims of chemical disasters? Finally, I'm glad that Mr. Pimentel recognizes the importance of providing the public with expert information about scientific issues. But I've noticed that so far, most such information has come from scientists who represent the government. All this makes me extremely suspicious of the proposal that the media should "cooperate" with scientists.

ROBERT J. HALL
San Francisco, Calif.

Mr. Pimentel replies:
The chemistry community is very concerned about chemical disasters. I urge Mr. Hall to read the February 11, 1985, issue of *Chemical and Engineering News*, which is entirely devoted to the tragedy of Bhopal. Perhaps he would be surprised by the same magazine's May 19, 1986, editorial on the Bhopal, Challenger, and Chernobyl accidents. Another issue of the magazine presents a broad view of the dangers and problems posed by the widely publicized toxic chemical dioxin. Publications from the American Physical Society could no doubt offer similar articles about Three Mile Island and Chernobyl.

Scientists' good faith is evident in their

Continued on page 78



A reading test.

A maze of garbled letters. That's just what 27 million Americans see when they look at a page of print. They couldn't distinguish this page from any other.

These Americans are functionally illiterate — on a one-way ticket to American poverty.

Illiteracy breeds frustration, anguish and crime. Its costs are enormous. Welfare checks, lost taxes, poor workmanship and remedial education amount to more than $200 billion a year.

Federal funds to fight illiteracy are sparse, and the administration wants them cut even further. Yet each year the number of functional adult illiterates grows by another 2.3 million persons.

To fight adult illiteracy, we need to stop the rising rate of teenage dropouts. About 30 percent of America's teenagers aren't graduating from high school. In large cities the dropout rate runs between 35-50 percent.

We cannot let almost a third of America's youth continue to drift toward hopelessness.

That's why the National Education Association has initiated a major new effort to rescue young people from dropping out. The NEA has established a $1.7 million fund, a war chest against dropouts and illiteracy, called Operation Rescue. And we're asking other concerned groups — both inside and outside education — to match us, dollar for dollar in our fight against academic failure.

Our goal with Operation Rescue: to cut the dropout rate in half by 1990, a significant step to stem the tide of illiteracy.

Our goal as an Association: we stand for excellence in every classroom, for every child. That has never wavered in 128 years.

nea

National Education Association

THE SUBJECT IS EXCELLENCE



Fiber optics: beyond 20,000,000,000 bits/sec.

Summary:

GTE scientists have demonstrated laser modulation and detection at rates as high as 20 gigabits/second. They have developed ultra-small lasers that have light emitting areas as small as 0.2 square microns. They are working to improve the glass fiber itself, as well as to produce optical analogs of electronic switches with the long-range goal of all-optical systems, in which message streams are switched as much as 10,000 times faster than at present.

GTE commercial involvement in fiber optics communications systems dates from the first such installation in Artesia, California, in 1977.

Our scientists developed the system's technology and equipment, and have been contributing to the state of the art ever since.

Current projects deal with increasing the capacity, the versatility, the applications of the systems; longer-term, we are exploring the possibility of all-optical systems.

Faster and faster...

Until recently, optical systems processed digital streams at speeds ranging up to hundreds of megabits per second.

Fast though that may seem, today's carriers are seeking speeds in the gigabits-per-second range. This might even permit the glass to be brought directly to satellite earth stations or microwave towers, for example, for direct conversion of radio signals to light.

Recently, GTE demonstrated the ability to turn diode lasers on and off at rates as high as 20 gigabits per second—about 333% higher than the greatest previously recorded speed.

...and smaller and smaller.

Such speeds require very special lasers. And, as you can see from the electron micrograph at upper right (the head of an ant looking at one of these lasers), it is extremely small.

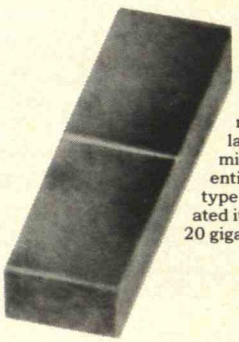
It was constructed on a wafer of InP, by epitaxial growth of a layer of InGaAsP approximately 0.1 micron thick. This was then etched to a mesa shape, and further layers of InP added.

The resulting laser cavity is approximately 0.2 square micron in area, and provides an excellent mate for single-mode glass fiber (fiber with a core of such small diameter that light travels a single path—mode—drastically lowering its dispersion within the fiber).

Switching light with light.

In another project, we are investigating the possibility of ultimately eliminating the electronics altogether by using optical switches.

We are working with materials whose indices of refraction vary with the intensity of incident light—a nonlinear response.



Head of an ant dwarfs a sub-micron-sized diode laser in this electron micrograph. GTE scientists developed this type laser, and have operated it at rates as high as 20 gigabits a second.

Ultimately, if it actually does become possible to switch systems optically, an improvement in speed of as much as 1,000,000% is theoretically possible.

In its brief history, fiber optics has made astonishing strides. At GTE, we are working to continue at the frontiers of this science—to make fiber optics an even more helpful technique to meet the endless needs of tomorrow's telecommunications.

The box lists some of the pertinent papers GTE people have published on various aspects of fiber optics. For any of these, you are invited to write GTE Marketing Services Center, Department FO, 70 Empire Drive, West Seneca, NY 14224. Or call 1-800-833-4000.



Pertinent Papers

High Frequency Modulation on InGaAsP Lasers: R. Olshansky and C.B. Su, 5th International Conference on Integrated Optical Fibre Communications—11th European Conference on Optical Communications, Venice, Italy, October 1-4, 1985.

140 Mb/s Transmission over 30 KM of Single-Mode Fiber Using an LED Source: L.W. Ulbricht, M.J. Teare, R. Olshansky, and R.B. Lauer, 5th International Conference on Integrated Optical Fibre Communications—11th European Conference on Optical Communications, Venice, Italy, October 1-4, 1985.

Tunable Multiplexer/Demultiplexer: Barbara Foley, John Carlsen, Paul Melman, 5th International Conference on Integrated Optical Fibre Communications—11th European Conference on Optical Communications, Venice, Italy, October 1-4, 1985.

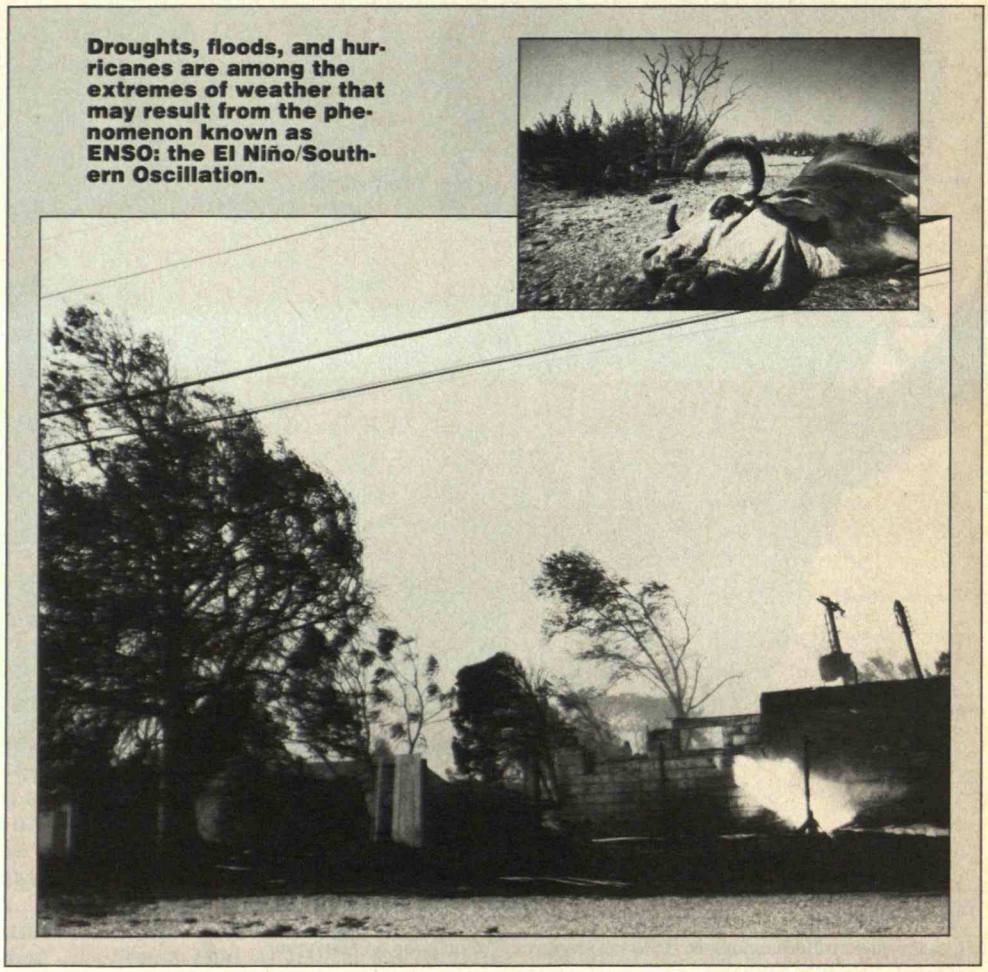
Frequency Modulation and Dynamic Lineshape Properties of Single Mode Semiconductor Lasers—Time Averaged Electric Field Autocorrelation Function Measurements: Elliot Eichen, Paul Melman, William H. Nelson, 5th International Conference on Integrated Optical Fibre Communications—11th European Conference on Optical Communications, Venice, Italy, October 1-4, 1985.

Room Temperature Optical Bistability in InGaAsP/InP Amplifiers and Implications for Passive Devices: W.F. Sharfin and M. Dagenais, Applied Physics Letter 46(9), 1 May 1985.

Time and Wavelength Resolved Nonlinear Optical Spectroscopy of a Polydiacetylene in the Solid State Using Picosecond Dye Laser Pulses: G.M. Carter, M.K. Thakur, Y.J. Chen and J.V. Hryniewicz, Applied Physics Letter 46(9), 1 May 1985.

GTE

Listening to the Weather



Droughts, floods, and hurricanes are among the extremes of weather that may result from the phenomenon known as ENSO: the El Niño/Southern Oscillation.

Between the summer of 1982 and fall of 1983, the worst drought of the century devastated Australia. Meanwhile, Peru, Ecuador, southern Brazil, northern Argentina, and Paraguay nearly washed away in dramatic floods. Drought plagued southern Africa; mudslides spread across California. The southeastern United States was subjected to floods and storms, while the Northeast basked in a mild winter, and drought diminished corn and soybean harvests in the Midwest. Five hurricanes smashed into normally serene Pacific islands, including perhaps the most severe one to strike Tahiti in modern times.

These disturbances are among the many that have been blamed on the El Niño/Southern Oscillation (ENSO)—a dramatic alteration in the circulation patterns of equatorial Pacific waters (El Niño) and atmosphere (Southern Oscillation). Earlier warning that an ENSO is underway could greatly reduce the economic displacement it causes, notes Jack Sherman, chief of the research planning group at the National Environmental Satellite Data and Information Service. The service is part of the National Oceanic and Atmospheric Administration. Sherman says that with even six months more warning "certain crops might be planted or not planted." David Palmer, a physicist at the Atlantic Oceanographic and Meteorological Laboratory, is working with mathematician Linda Lawson, physical oceanographer David Behringer, and computer specialist Yeun Daneshzadeh to help provide that additional warning.

Ordinarily, the South Equatorial Current carries cold water that rises from the depths of the eastern Pacific toward the western Pacific. During an El Niño, this current slackens and may even reverse, letting warm waters into the eastern Pacific. This affects climate all along the Pacific coast of the Americas. As part of the same pattern, the Southern Oscillation causes what Palmer calls a "sloshing back and forth of the mass of the atmosphere between the Indian Ocean and the eastern Pacific." This influences air-pressure differences between the two regions, so that prevailing wind patterns reverse.

The ramifications of an ENSO extend well into the northern and southern hemispheres, altering the course of the jet stream. Weather patterns over both North America and New Zealand are affected. Indeed, "on time scales from a few months to two years, most climate variations are due to the El Niño/Southern Oscillation phenomenon," Palmer observes.

However, the global changes in wind patterns, precipitation patterns, and oceanic temperature and circulation that indicate an ENSO are difficult to detect. These different climatic parameters may appear to change in unrelated ways. In September of 1982, several months into the most powerful El Niño/Southern Oscillation of the century, an international committee on predicting such events could not decide whether an ENSO was taking place, let alone when a future one would occur. One key parameter indicated that an ENSO was underway, but others suggested it was not.

To help clear up such confusion, Palmer and his colleagues employ computer models and the relatively new discipline of acoustic tomog-

PHOTOS: OWEN FRANKEN, GREG SMITH/STOCK BOSTON

raphy—using sound to reveal temperature and density variations across vast stretches of ocean. In acoustic tomography, a network of receivers picks up signals emitted from a network of sound sources. The temperature and salinity of the ocean at various depths affect the speed at which sounds travel, and as a result signals arrive at the receivers at different times. From the times derived from many source-receiver pairs, oceanographers can make a map that shows the temperature of the ocean at various depths. "Most people think it's the only viable way of monitoring the interior of the ocean," Palmer says.

To the researchers' surprise, a computer model of how sound travels in the ocean indicates that during an El Niño the warm waters between the ocean surface and about 300 yards below should bend sound waves sharply downward. The sound waves should be directed toward the bottom of the ocean: long-distance sound transmission should essentially cease.

To detect an ENSO, Palmer suggests establishing acoustic observatories, which could be "just little huts on the beach" on various tropical islands. These observatories would be linked to offshore instruments to pick up underwater sounds. If an El Niño occurs, low-frequency sounds from ships and other distant sources would be suppressed, reducing overall noise levels by about 10 decibels.

Palmer's group and researchers at the Scripps Institution of Oceanography are also working on mid-depth tomography—focusing on events below the warm surface layer of the sea. It is thought that surface-layer changes may affect these deeper waters. Although Palmer notes that the initial computer modeling "looks favorable," feasibility studies for mid-depth tomography probably will not be completed until late next summer.

Palmer emphasizes that all conclusions so far are based on computer modeling of data collected during the 1982-83 El Niño. He hopes to complete a feasibility study for a field experiment by the end of 1986. The experiment itself would begin next year.

If successful, Palmer's techniques would supplement other measures already in use. According to John Wallace, professor of atmospheric sciences at the University of Washington, these include calculating the difference in atmospheric pressure between Tahiti and Darwin, Australia; measuring the wind on three islands along the equator; and gauging rainfall at Australia and several tropical islands. Scientists also monitor sea-surface temperature along the coast of South America and check sea level at a network of islands across the South Pacific. In addition, current meters are moored at key locations, and buoys that drift with the currents periodically announce their positions via satellite.

Many of these efforts were started or greatly expanded after the 1982-83 ENSO. Nonetheless, notes Wallace, the information they provide is "often confusing and contradictory." Early in 1986, he explains, "a number were pointing to an incipient El Niño," but right now nothing out of the ordinary seems to be on the horizon. "It's been very humbling to be in the position of having to interpret data in real time. It's so much easier to make forecasts in hindsight," muses Wallace.—*Frank Lowenstein*



Hypersonic Hyperbole

Robert S. Cooper, former head of the Defense Advanced Research Projects Agency (DARPA), believes that an aerospace plane would liberate civilian and military space programs from a technology whose risk is inherently and unacceptably high. Weeks before the *Challenger* accident, he told a meeting of the Macro-engineering Society, "Every time you launch a rocket into space, it's a miracle."

However, Stephen W. Korthals-Altes deplores the "hypersonic hyperbole" in the selling of the aerospace plane as a successor to the space shuttle, a central element in the Strategic Defense Initiative, and an "Orient Express" capable of carrying commercial traffic at competitive prices. Korthals-Altes completed an M.I.T. graduate thesis on the subject last spring.

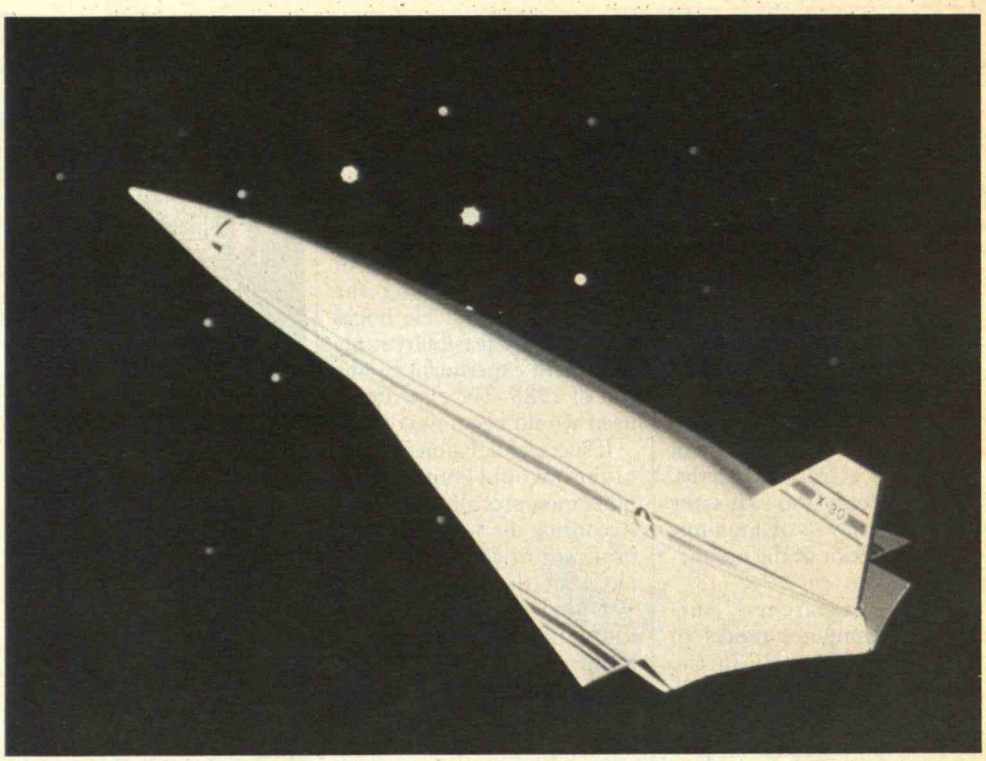
The present push for a hypersonic aircraft began late in 1985, when President Reagan and his then science advisor, George A. Keyworth II, put $500 million for preliminary studies of the so-called National Aerospace Plane into the 1987 budget. In his 1986 State of the Union address, Reagan described an aircraft that could "take off from Dulles Airport and accelerate up to 25 times the speed of sound, attaining a low-earth orbit, [and] fly to Tokyo within two hours." Keyworth advocated hypersonic transport as a leapfrog over an intermediate supersonic transport—"a true double jump in technology." He even predicted New York-Tokyo tickets priced competitively with those of today.

Three technological advances make the aerospace plane conceivable, say advocates. First, powerful computers can improve design and testing by simulating supersonic flight. Second, researchers have developed materials that retain their strength at the high temperatures of supersonic flight. Finally, advances in propulsion may enable engines to operate at high speeds in very thin air.

In explaining his enthusiasm for the aerospace plane,

ILLUSTRATION: JON McINTOSH

The hypersonic plane is proposed as a successor to the space shuttle, a key element in SDI, and a commercial transport.



Cooper cites a fundamental distinction between jet and rocket propulsion. A jet engine requires only fuel, because it draws oxygen from the atmosphere to burn the fuel. Not so a rocket: both fuel and oxidizer must be carried aloft, and 90 percent of the launch weight of most rockets—including the shuttle—is oxidizer. An aerospace plane that carried only enough oxidizer for maneuvering in space would be smaller, lighter, and far more efficient than the shuttle.

Conventional jet engines are inefficient at speeds over Mach 1, the speed of sound. A ramjet engine solves part of the problem. In a ramjet, which becomes efficient at roughly twice the speed of sound, the speed of the aircraft itself rams the air through the engine, providing the compression necessary for combustion. When the vehicle is flying at six times the speed of sound, however, air would ram through the engine at supersonic speed and interfere with the burning of fuel. So a different configuration—a "scramjet"—is necessary. A scramjet begins to operate when a plane is flying at Mach 4 and theoretically could function at Mach 24, enough to orbit an aerospace plane. Cooper told the Macro-engineering Society that DARPA had built an engine capable of operating with supersonic as well as subsonic air flow—in effect a combination ramjet/scramjet.

For critics such as Korthals-Altes, the scenario of a multipurpose aerospace plane is simplistic. A casual reading of many reports does yield the impression of a single jack-of-all-trades vehicle, modified slightly for each of its three different missions. However, the space plane's advocates really mean that the ramjet/scramjet and thermal-protection technologies to be developed could be applied to more than one kind of system—including a hypersonic transport, a weapons system, and an orbiter to replace the space shuttle.

Korthals-Altes thinks that the shuttle replacement would be the plane's most promising task. It would be entirely reusable, so it would have fast turnaround time and vastly reduced requirements for support staff. Perhaps 350 people would be needed, compared with as many as 6,000 for the shuttle. And massive oxidizer tanks would not be needed, so the plane could sit horizontally on runways at large airports.

The Orient Express idea has met a cool reception in many quarters. John Steiner, former vice-president of Boeing, calls the vision of hypersonic New York-to-Tokyo travel "baloney." Steiner chaired a panel commissioned by the White House Office of Science and Technology Policy that targeted three top aerospace goals for the rest of the century. He says the industry would be saddled with an uneconomic alternative to what it could and should be planning—a good supersonic transport to succeed the Mach 2 Concorde.

Steiner thinks the real customer for a hypersonic aerospace plane is the military. But Korthals-Altes finds that military applications are hard to analyze because of the Defense Department's "reluctance (or inability) to specify what missions they believe are worthwhile." For the present, military officials discuss the aerospace plane with interest—but as a research assignment.

Cost is the toughest issue for aerospace-plane advocates. The official estimate of development cost is $3 billion. Yet Korthals-Altes cites an estimate by First Boston Corp., an investment firm, of $14 billion, and according to his own analysis, it should cost around $17 billion to develop a prototype for a scramjet-powered launch vehicle. A fleet of 10 aerospace planes might cost an additional $11 billion, so that a total of $28 billion would have to be spent before the investment begins to return income. Korthals-Altes puts operations costs at $5 million to $10 million per launch—about a tenth of what they are for the shuttle, but not low enough to make commercial service viable. Advocates claim the launch costs would be a hundredth what they are for the shuttle. Korthals-Altes concludes: "The aerospace plane is being oversold," technological difficulties downplayed, costs underestimated, and utility inflated.—*John Mattill*

Who Needs Mousetraps?

To ensure the safety of new food additives, chemicals, and cosmetics, researchers sacrifice millions of animals. Every year an estimated 17 to 70 million animals are used in laboratory research in the United States. Approximately 15 to 20 percent are used to find out if cosmetics and household products are hazardous.

University of Michigan researchers Frizell L. Vaughan and Isadore Bernstein have developed a procedure that could lead to a successful alternative to using laboratory animals to test whether products irritate human skin. They have found a new way to grow cells from the outer layer of human skin in vitro—that is, outside the body. Use of the technique to test cosmetics, dishwashing soaps, detergents, and other potential skin irritants could begin on a trial basis this fall.

While Vaughan and Bernstein's test might prove valuable in testing for irritants, animal tests continue to be the mainstay for detecting carcinogenesis and toxicity. David Ozonoff of the Boston University School of Public Health notes that almost every substance known to induce human cancer has been shown to cause tumors in animals. "For the time being," he believes, "animal tests are the only show in town." He says that scientists will continue to use animals in cancer research until more is learned about how cancers start on the cellular level.

Most current regulations require that animal tests be conducted before products can be approved. However, regulatory pressure can cut both ways. Since 1966 the Animal Welfare Act has required humane treatment of laboratory animals. The cost of complying with this act was increased in 1985 by strengthening amendments that, for example, call for measures to promote "the psychological well-being of primates." Under other new federal regulations, institutional committees must review all research projects using animals, whether federally funded or not.

Such financial considerations make alternatives to animal experimentation especially attractive to researchers and companies. In addition to reducing the number of laboratory animals necessary, tests using the procedure developed by Vaughan and Bernstein take several days instead of several months. Vaughan says that industry representatives have expressed interest in the Michigan research.

To test if substances irritate human skin, Vaughan and Bernstein's group grows skin cells in culture in such a way that they recreate the epidermis—the outer layer of skin. Vaughan emphasizes that he and Bernstein are "not just growing cells, but creating a micro-environment that can replicate our skin's natural barrier to foreign, toxic substances." He hopes that such tests can help to "understand the mechanisms of action"



University of Michigan researchers Frizell Vaughan and Isadore Bernstein (above) have developed an alternative to using mice to see if products might irritate human skin. They grow a layer of human skin on top of a synthetic membrane (left), which can then be used to test the products.

PHOTOS: DOD; UNIVERSITY OF MICHIGAN

through which foreign substances affect the skin of an organism.

Unlike previous efforts to replicate skin, the Michigan work adds nothing to the original cells. It also exposes the cells to air rather than keeping them in solution. Bernstein says the exposure to air "seems to account for the fact that the cellular structure mimics that of the outer skin of an organism." Previous efforts have not yielded this effect.

Because they use human cells, Vaughan and Bernstein avoid one major scientific objection to animal testing—that what is true for one species may not be true for another. It has been known for some time that many agents that irritate the skin of rabbits do not seem to affect humans. But many other objections to extrapolating human risk from animal studies apply to the Michigan tests. These problems include translating data from a relatively homogeneous laboratory situation to a heterogeneous human community, and extrapolating from controlled, single-source exposure to real-life situations in which many factors interact.

Other alternative tests are being developed for specific applications. Several researchers are looking for a replacement for the Draize test. Used to determine whether a substance would harm the human eye, a Draize test requires killing numerous rabbits. At the Medical College of Pennsylvania, Joseph Leighton has developed a new test that uses chicken embryos. His work is being studied by scientists at Colgate-Palmolive, which uses 45,000 mice and rats annually.

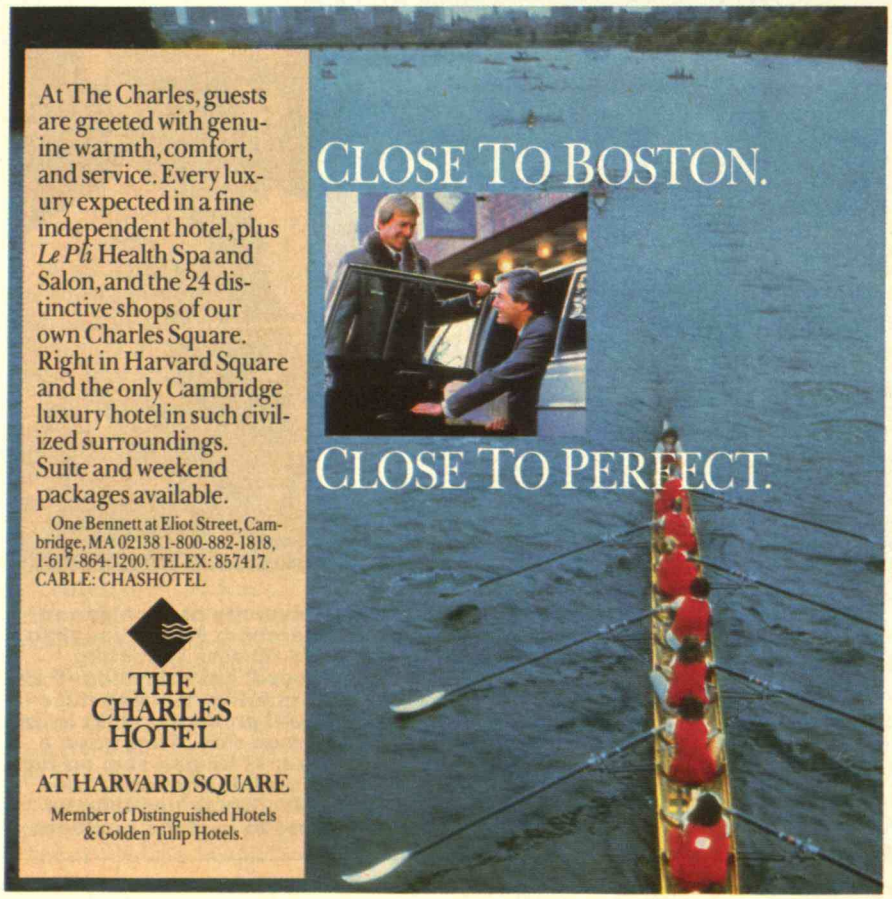
A replacement for the Draize test developed by Marcia Jumblatt and Arthur Neufeld of the Eye Research Institute of Boston involves growing tissues from the cornea of a rabbit's eye in vitro. One rabbit can provide enough tissue for many tests, so costs are cut. And, says Neufeld, "Not only is the Draize test a poor way to treat animals, but the in vitro method appears to be far more sensitive and far more relevant."—*Seth Shulman*

Six-Billion-Dollar Prize

In 1995, a peaceful rolling prairie somewhere in the United States may yield little hint that deep beneath the quiet landscape lies a circular concrete tunnel, roughly 100 miles in circumference, where temperatures can be hotter than at the core of the sun. The tunnel would be at the heart of the Superconducting Super Collider (SSC), the world's most powerful atom smasher, and the incredible heat created by protons accelerated to almost the speed of light.

The SSC is a proposed proton synchrotron, one of several devices used to smash atomic particles into smaller particles. Its power would be rated at 40 trillion electron volts (TeV). Many states are lobbying vigorously to show their enthusiasm for hosting this Department of Energy (DOE) project. "I don't think it's maligning anyone," says DOE spokesman Alvin Trivelpiece, "but I don't think I've heard from Rhode Island."

Sherry Patten, director of public information in Denver's Department of Local Affairs, has become an expert on nuclear accelerators because Colorado is a chief contender. Texas has reportedly offered 35 university chairs to scientists working with the SSC, a major academic commitment. And both Texas and Illinois have set aside millions of dollars to help pay for the project. Illinois won the last such contest with the construction of the 1-TeV Tevatron at the Fermi National Accelerator Laboratory (Fermilab) in Batavia.



Like Fermilab's particle accelerator shown here, the proposed Superconducting Super Collider should not disturb the environment.

SSC is indeed a prize. When George A. Keyworth II was still Reagan's science advisor, he noted that the site of the supercollider would be "the international center for much of experimental physics, a place that draws the world's best minds." According to Uriel Nauenberg, a leading particle physicist at the University of Colorado at Boulder, the SSC would be "the premier research tool for high-energy physics."

The love of science is not the only attraction of SSC. The SSC's expected annual budget of $300-million and staff of 3,000 scientists, engineers, technicians, and administrators would boost the winning state's economy. The six-year, $6 billion construction phase would generate 5,000 temporary jobs.

Moreover, the SSC lacks some drawbacks of most massive projects. Though it would be the largest machine ever built, the land above it would be undisturbed, and could retain traditional roles for agriculture and wildlife. The land above the Tevatron accelerator, which is four miles in circumference, is home to a bison game preserve. Leonard Slosky, science and technology advisor to Colorado governor Richard Lamm, claims that the radiation effects of a proton accelerator are minimal, even to the people who work directly around it. The experiments would generate only about 1 to 2 percent of the normal background radiation in Colorado. Also, Slosky contends that the SSC couldn't become a hazard in the case of an accident. He compares the machine to x-ray equipment. "When you turn off the switch, it's off. There's no accident scenario."

This enthusiasm at the state level may not be matched in Washington. Leon Lederman, director of Fermilab, points out that the government will be asked to spend an estimated $6 billion for a device that produces mere scientific findings. "All we can say is, first, this is very good science. Second, we're terribly sorry it's so expensive," Lederman says. Colorado's Patten thinks that in an era of funding cutbacks, "the main competitor for the SSC dollar will be the defense budget." However, some scientists fear more that SSC funding will drain money from less glamorous smaller-scale basic research.

Recently the Soviets announced that they would complete a super collider by 1993, and the debate about whether to build the SSC shifted. Now competition and national prestige are involved. As Slosky puts it, "The high-energy physicists believe this type of machine will eventually be built. It's a question of whether the United States maintains its lead in this field, or if it's overtaken by the Europeans or the Soviet Union."

The Russian accelerator will be 13 miles in circumference and accelerate protons to three TeV. It is being built in Serpukhov, about 60 miles south of Moscow. "The Soviets would have the highest energy by a substantial factor for a long time if a large new atom smasher is not built in the West," predicts Lederman. His basic concern is that the Russian accelerator "would not be nearly energetic enough to address all the current questions."

The SSC, which would raise its proton beams to 20 TeV, should be energetic enough. The protons would travel in opposite directions in each steel pipe. For the most part, these particles would pass one another unscathed, but occasionally two would meet in a 40-TeV collision. A few of the clashes would be violent enough to break the protons down into quarks or even smaller sub-particles. "It's a bit like finding out how cars work by smashing them together and seeing what falls out," explains Carlo Rubbia, a high-energy particle physicist at Harvard. "But in particle physics, when you smash two cars together, you get 20 or 30 new cars, or even a truck or two."

The SSC would provide unparalleled and undisputed insight into elementary particles. Particle physicists currently have theories about different aspects of their field but lack a fundamental, unifying theory. The events that occur when protons are accelerated to 10 TeV or higher should begin to provide the basis for such a theory. Some physicists believe the further breakup of particles would reveal keys to understanding the basic composition of the universe, the fundamental nature of energy, and the relationship of energy to currently held concepts of time. Says Nauenberg, "When the universe started, the only particles that existed were quarks and electrons. The purpose of the SSC is to find out what happened in that first tenth of a second of the universe."

—Keith R. Worfolk



PHOTO: FERMI LABORATORY

Asbestos Debate Goes On

U.S. consumption of asbestos has plummeted from almost 900,000 tons in 1973 to under 200,000 tons in 1985. New and proposed regulations could end asbestos use entirely, even though the industry has struggled to combat concern about health hazards.

In July 1986 the U.S. Occupational Safety and Health Administration (OSHA) dropped the permissible exposure levels for workers from 2.0 to 0.2 fibers per cubic centimeter. Sweden recently banned asbestos in car brakes. Most importantly, the U.S. Environmental Protection Agency (EPA) has proposed to prohibit several major uses of asbestos, including asbestos in cement pipe, floor tiles, and clothing. Moreover, the agency recommends phasing out all use over a 10-year period.

In the 1960s, manufacturers responded to the first studies of asbestos dangers by eliminating products in which the material can be crumbled by hand and made airborne. Today's products have asbestos "locked in." For example, asbestos-cement pipe theoretically produces little or no exposure, since the fibers are bound into the cement.

On the other hand, fibers may still be released, perhaps contaminating drinking water that runs through the pipe. Some studies, including one by the National Research Council, suggest that asbestos in drinking water may cause digestive-tract cancer.

Moreover, the manufacture of any asbestos products can lead to high exposures for workers. The industry therefore endorses banning high-speed abrasive disc saws in production, and has long promoted cutting tools with local exhaust ventilation. The Asbestos Information Association (AIA) says that if these changes were made, asbestos, like radiation, could be used safely. To research other ways of minimizing workers' risks, the industry set up the Asbestos Institute for Occupational and Environmental Safety and Health and the Institute for Applied Fibrous Dust Research.

The measures that help protect workers in manufacturing plants rarely protect construction workers, notes Joseph L. Durst, Jr., director of occupational safety and health for the Carpenter's Union. To minimize the amount of field fabrication, the industry produces asbestos pipe in a wide variety of sizes and shapes. This can eliminate some of the cutting necessary during installation, but machining during repair or removal could cause problems later.

Based on evidence presented by the asbestos industry, Canada's Royal Com-

SATELLITE I:

Satellites orbited by the navy to help ships navigate will soon make obsolete the semaphores and lights that have for a century told railroad engineers to speed up or slow down their trains. Using signals from Navstar satellites, receivers and computers on 12 Burlington Northern Railroad locomotives calculate to an accuracy of 150 feet each train's location. The information is sent to a distant dispatcher. With information from other trains, the dispatcher can tell each engineer when to go, stop, or take a side track.

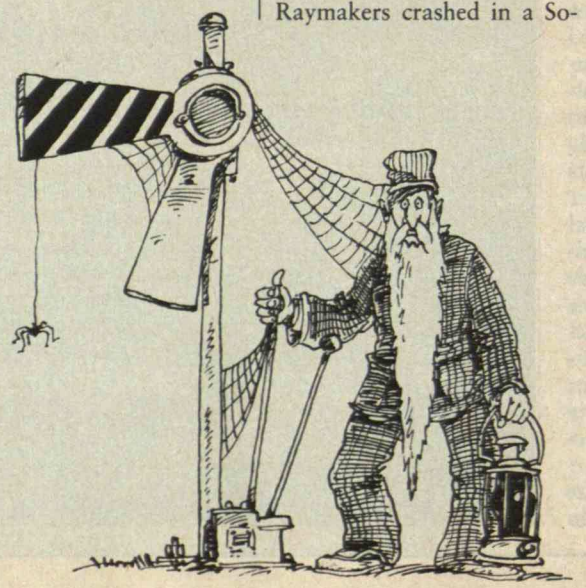
When the Navstar system is completed in 1988, Burlington Northern will abandon its block signals. Furthermore, says Steven Ditmeyer, Burlington Northern's director of research and development, on-train computers programmed with topographic maps will tell each engineer the most fuel-efficient speed for each hill and curve. The savings should more than compensate for the cost of the new equipment since Burlington Northern, the country's longest rail network, uses $500 million of fuel a year.

SATELLITE II:

In December 1984, in the midst of a 30-week auto race, Serge Goriely and Phillipe Raymakers crashed in a Somalia jungle. But when Raymakers activated the COSPAS/SARSAT beacon they carried, they were rescued. They could even rejoin the race.

COSPAS/SARSAT, the search and rescue satellite organization, has helped save 600 lives since 1983. Anyone with a small transmitter, which costs about $200, can receive the benefits for free. "We will service anybody. Our system is essentially blind to national boundaries," says Fred Flatow, SARSAT mission manager.

International cooperation is key to the organization's success. SARSAT stands for the U.S. Search and Rescue Satellite Aided Tracking System. COSPAS—Cosmicheskaya Systema Poiska Avarinix Sudov—is Russian for space system for the search of distressed vehicles. The two nations provided the satellites, and other SARSAT/COSPAS partners are France, Canada, Norway, Bulgaria, Sweden, Finland, the United Kingdom, and Denmark.—*Joe Lovece*



FREE-NET:

In Cleveland, Ohio, physicians make house calls by computer—and so do dentists, lawyers, and even veterinarians. The Cleveland Free-Net, which opened in July 1986, is the nation's first free, open-access community com-

ILLUSTRATIONS: JON McINTOSH

mission on Matters of Health and Safety Arising from the Use of Asbestos concluded that the dangers of asbestos exposure in buildings are minimal compared with the dangers that can occur when the material is disturbed during removal. Canada is the United States' principal supplier of asbestos and the world's second largest producer after the Soviet Union.

Industry-funded research also suggests that low-level exposure is not hazardous. But OSHA maintains that there is no threshold for carcinogenesis and that exposures must be reduced to the lowest level feasible. The agency estimates that although its new regulations will greatly reduce levels, 6.7 cancer deaths and 5 deaths from asbestosis, a disabling lung disease, will result for every 1,000 workers.

Finally, asbestos defenders say that all types of asbestos are not equally dangerous. Almost all asbestos mined in Canada and used in the United States is chrysotile or "white," and according to Asbestos Institute consultant Arthur Langer of Mount Sinai Center in New York, this type is relatively safe. Crocidolite ("blue") and amosite ("brown") asbestos are much more hazardous, he says. Sweden and other countries have banned only crocidolite, and Sweden has called for a worldwide ban of it as well.

OSHA, however, refuses to distinguish among the fiber types, arguing that all are carcinogenic. The great majority of exposures come from as-

MINITRENDS

puter system. Anyone in the Cleveland area with a personal computer and a modem can use it.

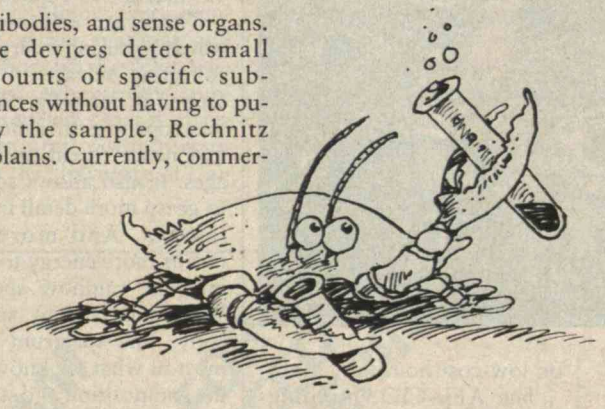
Located at Case Western Reserve University, the Free-Net is an "electronic city," complete with an electronic mail "post office," a "schoolhouse" for students at public and private institutions, and a "hospital" and "courthouse" where qualified professionals answer questions. Through a "government house," citizens may contact elected officials and a "public square" includes a "podium" for electronic speeches. Virtually the entire system is run by volunteers.

Free-Net is the brainchild of Case Western Reserve professor Thomas M. Grundner. He sees a parallel between the free public-library movement in the nineteenth century and a new free-computing movement. To further this new movement, Grundner is making the software available for $1 a year to any city in the country.

CRAB SENSE:

Garry Rechnitz, a chemist at the University of Delaware, says crabs can help build an extraordinarily sensitive and precise analytical tool, a new kind of biosensor.

Biosensors combine electrodes with specific biological detectors such as enzymes, antibodies, and sense organs. The devices detect small amounts of specific substances without having to purify the sample, Rechnitz explains. Currently, commercial applications for biosensors are in health care, the food industry, defense, and environmental monitoring.



"Direct analysis is important," says Rechnitz, "because purifying a sample can be time-consuming and expensive. Also, the process often destroys fragile, potentially important components of the sample."

Stuart Belli, Rechnitz's collaborator, told the American Chemical Society that the University of Delaware team had created a biosensor by attaching the cut-off antennae of blue crabs to electrodes. The biosensor detected amino acids, the building blocks of proteins, in solution down to about three parts per million.

"That level of sensitivity isn't bad for a first attempt," notes Rechnitz, "but the most exciting finding was the response time." After the device signaled the presence of an amino acid, it could "recover to signal again in a matter of seconds. Most other biosensors require minutes."

NUKE FUTURE:

In August 1986, the Nuclear Regulatory Commission (NRC) issued a policy statement that broadly defines "an acceptable level of risk" from nuclear-power plants. The statement results from evaluations in the wake of Three Mile Island.

The first of two qualitative goals is that the operation of nuclear-power plants should create "no significant additional risk to life and health" for individuals. Also, risks to society "should be comparable to or less than the risks of generating electricity by viable competing technologies."

The statement also sets quantitative goals. For people near a plant, the risk of dying as a direct result of an accident should not exceed 0.1 percent of "the sum of prompt fatality risks" from other causes. The risk of dying from cancer should be just as low.

Two of the three NRC commissioners endorsed the policy statement, but with reservations. James Asselstine emphasizes that accidents can't be ruled out. Higher standards are needed to prevent a "substantial release of radioactive materials to the environment, given a core meltdown," he says. He also feels the commission should "decide the appropriate way to conduct cost-benefit analyses." Finally, he writes, "I would have required the next generation of plants to be substantially safer than the currently operating plants."

Commissioner Frederick Bernthal notes that the NRC refused to give "clear, unambiguous, practical safety objectives" in response to the question "How safe is safe enough?" He observes that the public judges nuclear power by a unique standard, and in refusing to recognize this, the commission threatens future industry development. "The issue today is not so much calculated risk. The issue is public acceptance and, consistent with the intent of Congress, preservation of the nuclear option."



Despite new safety measures, critics still want asbestos banned.

bestos already in buildings, and more than one type of asbestos is usually present; distinguishing between fiber types is not practical.

The Office of Management and Budget (OMB) delayed hearings on the EPA proposals for two years. A congressional investigation revealed the reason: OMB had promised Canadian officials to fight the ban. During the nine days of hearings that were finally held this July, the AIA and Canada's Asbestos Institute said asbestos could be used safely with the proper tools and procedures. Industry officials from Switzerland, Mexico, Brazil, Nigeria, and Canada asserted that the Third World needs asbestos cement products for water-supply pipe and for roofing on low-cost housing.

The AFL-CIO, building-trades unions, the Environmental Defense Fund, and other environmental groups joined victims' organizations such as the White Lung Association to testify in support of the proposals. All contended that even the new OSHA regulations were inadequate. They also emphasized that asbestos substitutes such as ceramic fibers must be tested for safety.

Central to the controversy was a statement on asbestos by the U.N.'s International Labor Organization (ILO). After two years of meetings, the ILO had endorsed substitutes and better tools and work practices.

EPA is expected to make a decision next year. Meanwhile, as the scientific and policy debates proceed, the steady decline of asbestos use continues.—*Scott Schneider*

Eye on the Sky

Astronomers and engineers are designing a telescope that defies age-old limitations. Telescope quality has almost always been constrained more by the products of glassmakers than by the skill of opticians. The opticians will take a giant step forward with the completion of the Keck telescope, whose mirror assembly will measure 10 meters—394 inches.

There are enormous rewards for using a large light-collecting surface in a telescope. It not only enables a telescope to gather more light and hence reveal fainter images. It also allows scientists to grasp more detail in bright images. And more light means more energy to spread into the rainbow spectrum. When analyzed by spectroscopy, this spectrum reveals most of what we know about the composition and structure of objects in space.

Yet no one has made a successful telescope mirror larger than Palomar's 200-inch disc, which was cast in Corning Pyrex half a century ago. The Soviet 236-inch telescope is infamous for the low quality of its mirrors, although several have been tried. There are proposals to cast mirrors up to half again as large as Palomar's using new technologies such as the University of Arizona's exciting spin-casting process, but no one has actually succeeded yet. In spin casting molten glass is rotated into the approximate shape desired, and then cooled to rigidity while still spinning.

Whenever small mirrors have been grouped into an aggregate, image quality has suffered. The assembly has never quite acted like a single large mirror. Another alternative, the Multiple Mirror Telescope at Whipple Observatory south of Tucson, Ariz., teams six identical telescopes in a common mount. Their light feeds into a single point-focus that is extremely effective for spectroscopy. A drawback is that only small objects can be photographed because the fields of view of the six telescopes are slightly tilted to one another. Only the central zone is in focus for all six simultaneously.

The Keck will be a segmented mirror telescope. The primary mirror will consist of 36 six-foot hexagonal segments that will act like a single piece of glass. Since the segments have their own peculiar internal stresses, a slight warping will result when each is trimmed to a hexagon. This warping will be corrected either by locally polishing down high zones or by pushing them back into shape with a static warping harness.

Another problem is that gravity will bend the steel structure supporting these segments as the telescope tilts to track objects across the sky. Therefore, to keep the array optically aligned, each segment will be fitted with devices to correct its position. A computer will continually adjust all 36 segments to make the array imitate the qualities of a rigid unit.

The surface of each segment must be an unusual section of a paraboloid, a difficult curve to grind. This will be solved by using the "stressed mirror polishing" technique developed at Berkeley and Tucson. The mirror blank is fitted with struts all around, which are pushed up or down with predetermined forces. This

PHOTO: EARL DOTTER/AMERICAN LABOR

warps the blank in just the right way so that when the stresses are relieved, the spherical curve relaxes into the desired shape.

A monolithic mirror big enough for Keck would weigh so much that it would be prohibitively expensive to support, even if it were possible to cast one. But the segments of the Keck mirror will be relatively thin, so their total weight will be perhaps an eighth of what a monolith's would be. The segmented mirror will weigh about 15 tons, comparable to monolithic mirrors less than half its diameter. The computer-designed support structure will be correspondingly light, built from conventional steel pipes. The compact framework will require a dome only as large as the one at Palomar, even though Keck will gather four times as much light.

One of a Kind

Small prototypes have demonstrated how everything should work, but when the full telescope is assembled, it will be the only instrument of its kind. Researchers are confident that Keck will be successful, and their confidence is based on their experience with the projects from which Keck's modeling tools were derived. "Almost every component, aspect, material, and dimension of the telescope has been exhaustively computer modeled," says Barbara Schaefer, staff research associate at the University of California.

The complete structure with the first six mirror segments will be tested at sea level in late 1987, and the completed instrument could see first light as early as 1990. The observatory to house the structure is already under construction at one of the very finest sites on this planet—Mauna Kea, Hawaii (elevation 13,600 feet). Half a dozen important telescopes already sit atop this (presumably) dormant volcano, where the air is thin, stable, and clear. Infrared astronomy benefits from the minimum of absorbing water vapor. Clouds are rare, and turbulence is less a problem than almost anywhere else.

Many of the observations made with Keck will be automated and handled by remote control, preferably from home offices in California. While some remote observing has been done with other telescopes, those who work with Keck are expected to do more than anyone has so far.

The project has been long under development by four University of California campuses—Berkeley, Los Angeles, San Diego, and Santa Cruz—the same group that operates Lick Observatory atop Mount Hamilton. The University of California will cover operating expenses, and other funds have come from a bequest from the W.M. Keck Foundation, which mostly serves Caltech in Pasadena. Consequently, Caltech and the University of California will share the project.—*Norman Sperling*

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ROBERT C. COWEN

The Case Against Pork Barrel Funding

REP. Robert S. Walker (R-Pa.) calls it "hog heaven." Defense Secretary Caspar Weinberger says it could jeopardize the preeminence of American universities. Sen. Dennis DeConcini (D-Ariz.) insists that it corrects a fundamental flaw in federal research grants, one that leaves many universities and colleges "picking up the crumbs."

From whatever perspective you view it, some universities' practice of appealing directly to Congress for research and construction money, instead of entering the traditional grant competition, has become a major budget factor. The so-called academic pork barrel has grown from about $3 million in 1982 to potentially well over $100 million in fiscal 1987, depending on the fate of legislation this fall.

The continued growth of this practice is alarming. It corrupts the merit-based process of research support that has been one of the strengths of American science and engineering. This process, in which expert reviewers select the best proposals from research groups competing openly for grants, helps keep science vigorous. Pork barrel funding also subverts Congress's own review process. This year, for instance, the House Appropriations Committee put language in a bill ordering the Department of Energy (DOE) to fund projects of which the House Science and Technology Committee was unaware.

Equally important, academic end runs divert attention from the urgent needs of most universities to buy new equipment, construct buildings, and generally upgrade seriously outmoded facilities for teaching and research. The White House Science Council study on the health of universities cited deteriorating facilities as a major threat. A committee of the National Science Board says the new laboratory facilities that are needed will cost $2 billion to $4 billion. Congress should be pressing the administration for an overall program to meet this national need. Instead, it's wrangling over efforts to help a few universities in an ad hoc and questionable manner.

Institutions that seek pork barrel funds say they are forced to go directly to Congress because they can't obtain funding otherwise. They claim that merit-based research funding is an elitist conspiracy, largely because members of peer-review teams tend to come from places that receive much of the research funding. As Sen. DiConcini notes, about half of all federal R&D funding goes to roughly 30 elite East and West Coast schools that have built up a formidable capability to carry out federally supported research over several decades.



Merit-based competition remains the best way to fund research.

This seemingly inequitable distribution is a sore point with many senators and representatives from other areas. Consequently, when university officials and their lobbyists go to Capitol Hill, they find champions to make their case in Congress.

There's not enough space here to list all the pork barrel projects approved in recent years or awaiting action for fiscal 1987. Rochester Institute of Technology, for instance, stands to obtain $11.1 million in 1987 for microelectronics and imaging work. Senate Majority Leader Robert Dole (R-Kan.) would see Wichita State and the University of Kansas, respectively, acquire $5 million and $1 million next year. And the Massachusetts congressional delegation is fighting for $13.5 million in air force money for Northeastern University. Ostensibly, these funds would pay for work on advanced integrated circuits and other research. But Northeastern wants to build a library with the money, and Congress seems prepared to let it spend the funds as it wishes.

One project considered last year—$10 million for a supercomputer for Cornell University—is no longer on the list. Cornell President Frank Rhodes turned down the unsolicited grant, saying that Cornell is submitting its bid to the Defense Advanced Research Projects Agency through the normal peer-review process.

There's not a great deal of money flowing to any one university as a result of congressional intervention. However, the sums that would be diverted in 1987 from the Department of Defense (DOD) and DOE are substantial—$65.6 million and $55.6 million, respectively. Of course, not all the money Congress earmarks for specific universities reaches those institutions. When Congress diverted similar amounts from these agencies' fiscal 1986 budgets, the administration rescinded the DOE funds and flatly refused to spend the earmarked DOD money. Thus, universities did not receive any pork-barrel money in the last fiscal year.

The issue has forged a strange alliance. Secretary Weinberger has joined his fiscal critic Sen. William Proxmire (D-Wis.) in denouncing raids on the federal budget. And, for once, they're allied with much of the academic scientific community. The National Academy of Sciences, the American Association for the Advancement of Science, and other mainstream groups have condemned the academic pork barrel.

The pork barrel provisions are still in the defense and energy appropriation bills Congress is considering for fiscal 1987. However, there does seem to be growing sentiment in Congress in favor of protecting the integrity of research funding through merit review. The defenders of this system will have a better chance of prevailing if the administration and Congress come up with a meaningful merit-based program to meet the pressing need for new university facilities across the United States. That would remove much of the incentive to subvert the traditional merit review. □



ROBERT C. COWEN IS SCIENCE EDITOR OF THE CHRISTIAN SCIENCE MONITOR *AND FORMER PRESIDENT OF THE NATIONAL ASSOCIATION OF SCIENCE WRITERS.*

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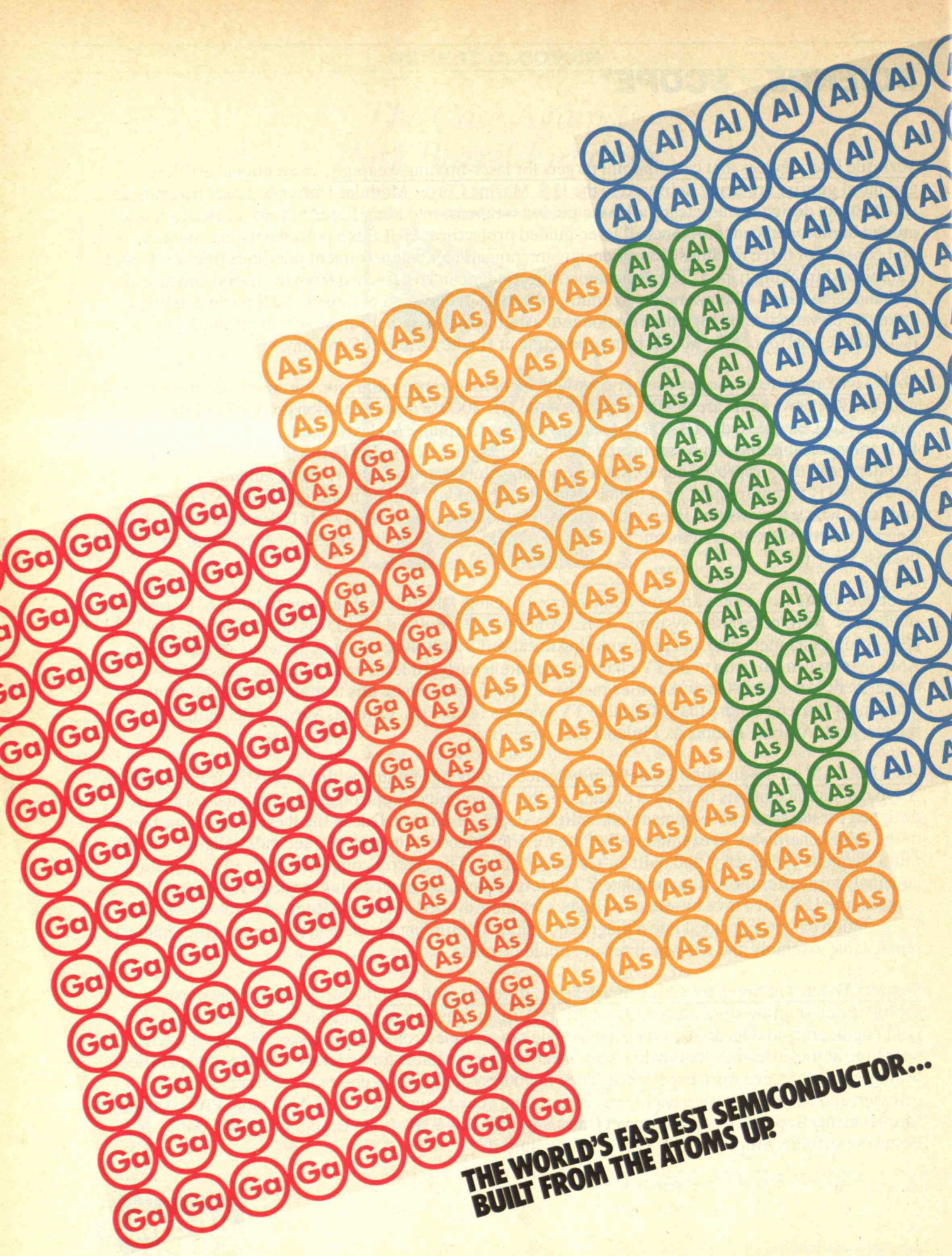
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Spray painting with atoms.

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LESTER C. THUROW

Who Said Military Dictatorships Are Good for the Economy?

APOLOGISTS for military dictatorships often assert that although generals may violate basic human values and democratic rights, they are efficient in promoting economic growth. They can keep wages down and restrict consumer spending in other ways so that capital is available to invest in technical change and economic growth. Not having to worry about elections, they need not sell out for short-term political gains. Or so the argument goes.

Chile, one of the few countries that currently has a military dictator, and Argentina, a democracy today but a country with a long history of military governments, provide interesting case histories for analyzing this argument. Both are potentially rich countries with abundant natural resources, and neither has any "natural" excuse for economic failure.

However, their record is not one of efficient economic growth. In Chile the generals seized power in 1973 to restore economic prosperity. Chile's per capita GNP had peaked in 1971 and then fallen 8 percent in the final two years of its last elected government. How much of this was caused by the bad economic policies of the Allende government and how much by American efforts to destabilize what U.S. officials regarded as a too left-wing government remains to be sorted out by future historians. This much we know: since the military took over in 1973, there have been ups and downs in the Chilean economy, but today the per capita Chilean GNP is right where it was 13 years ago.

A similar story can be told about Argentina. Military governments have been in charge on and off for most of the past half-century. In the last such episode, the per capita GNP fell almost 15 percent from its peak in 1979 until the generals left office in 1984. At that time the Argentinian per capita GNP was back to the levels of the mid-1960s. Under the generals' leadership, some 20 years had passed without any sustained rise in the standard of living.

The historical record seems clear: military dictatorships are not a shortcut to economic growth. But why?



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***Military** dictatorships are not a shortcut to economic growth.*

The diversion of too many economic resources—human and capital—to the military is one reason. Military governments may not be democracies, but their leaders also have to be politicians. They have to keep the rest of the military happy, and the best way to do this is to increase its funds. The fraction of GNP going to the military therefore tends to rise and "crowd out" other private and public investment activities. Instead of investing more in acquiring new civilian technologies, countries under military rule invest less.

Furthermore, it is faster to buy military equipment from international arms dealers than to learn to make one's own. As a result, countries often go into debt to purchase military equipment. In Argentina about one-third of the international borrowing that now weighs so heavily on the economy went to purchase high-tech military hardware. Such purchases do not generate a flow of salable consumer and industrial products that can help pay international debts.

In Chile, the militarization of industry is a large part of the problem. The heads of major firms are often generals on active duty who are rotated in and out of their jobs every two years as if business firms were just another military base. This happens because the military wants to be in charge of major firms, but officers do not want to leave real military activities for extended periods of time and lose their chances for promotion. As a result, the generals never really learn about what they are managing. Success is defined in terms of insuring order and political stability rather than in terms of promoting a faster rate of productivity growth or greater profitability.

Faced with non-performing economies, the military leaders of both Chile and Argentina resorted to international borrowing to restore economic growth. With borrowed money both countries experienced a short period of prosperity in the late 1970s and early 1980s. By borrowing to pay for both military and civilian imports, Chile and Argentina could consume more than they produced. At the peak of the Chilean boom, consumption was 50 percent above production.

Such prosperity cannot last. Eventually foreign creditors quit lending and want to be paid interest on their loans. At this point local consumption must fall below local production to pay the foreign lenders. That point has already arrived in many South American countries. Right now, Chile would have to give up 10 percent of its GNP to its foreign creditors, mostly American banks, if it were to make the interest payments that it is legally obligated to make. Chile is not paying the full 10 percent because to do so would force living standards down to a level that the generals fear would cause a revolution. But the country is paying 5 percent, and this means that Chileans must consume 5 percent less than they produce. And to keep the military happy, Gen. Augusto Pinochet has made all the cutbacks in the standard of living in the civilian rather than the military side of the economy.

Argentina no longer has a military government, but its present democratic government is faced with the daunting task of paying the bills run up by its previous military government. In both countries the foreign debt burden essentially forestalls future growth. If what is owed is paid, there is nothing left to invest in enhancing future production.

One often hears that military activities can lead to civilian spin-offs. In the under-

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developed world, the argument is that the military generates a supply of skilled workers who can make technologically sophisticated products. These people can then be used in the civilian industry to improve its technological base. The argument fails for two reasons.

The Spin-Offs Myth

First, the military does not want to lose skilled talent to the civilian economy. Not surprisingly, generals tend to think that the civilian economy exists to serve their needs. As a result, they encourage those with useful skills to become lifetime military personnel—not short-termers destined to spend most of their lives working for civilian firms.

Second, the military and civilian sectors of an economy have very different needs and incentives, and the military tends to inculcate habits that are counterproductive in civilian activities. If one is thinking about what is necessary to win a war, economic costs are rightly not a high-priority item. By its very nature, a military machine is not going to be cost-conscious.

The low priority of cost consciousness is particularly evident when the military runs its own production—a common practice in many countries ranging from Chile and Argentina to the Soviet Union. In such countries, military production costs are almost always higher even than in countries where the military places orders with private contractors. And as we in the United States know all too well, cost consciousness is not a very high priority under this system. Military personnel who learn their skills in an environment where cost reduction is not important are apt to take these habits with them into the civilian economy. Yet cost consciousness is precisely what is most needed in the civilian economy.

No one can argue that it is only the military dictators of the world who are so foolish as to neglect their civilian economies or mortgage their future with heavy international borrowing. The United States is now following the same path as Chile and Argentina, and recently became the world's largest debtor. However, it is equally impossible to argue that military dictators systematically avoid the self-indulgent mistakes that democracies commit. When it comes to economic planning, both forms of government seem to have difficulty escaping a short-term focus. □

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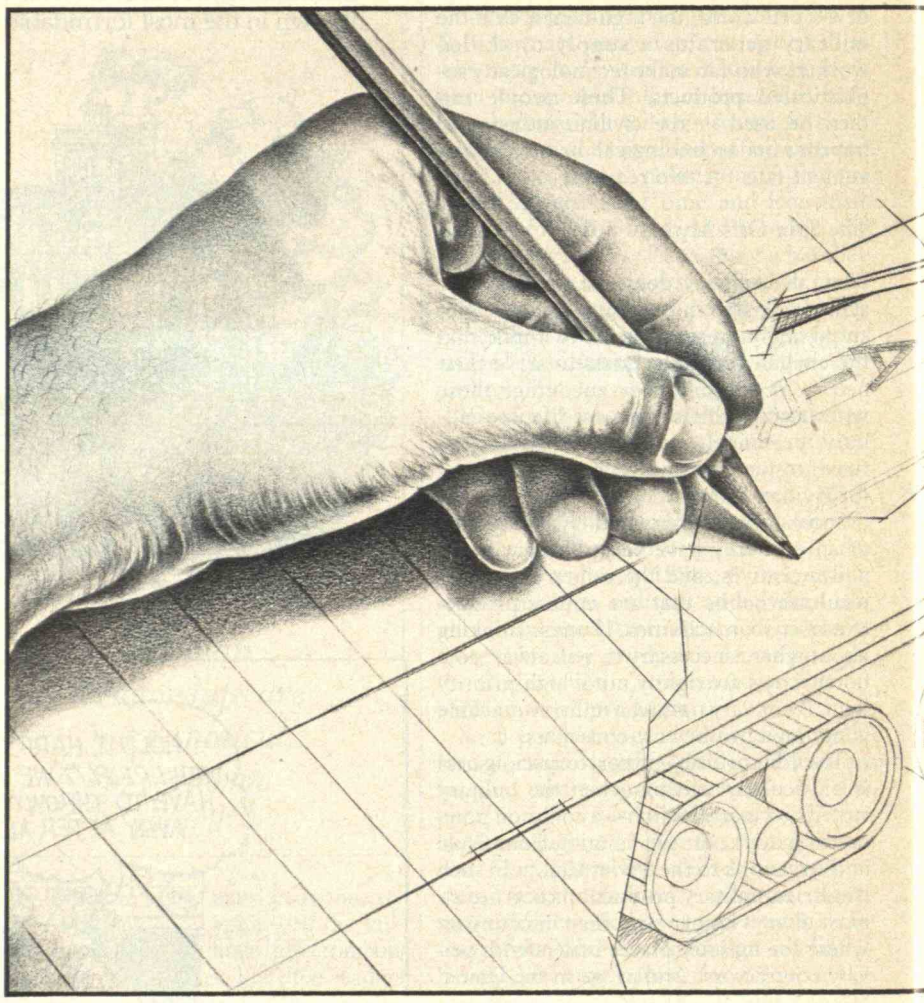
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BY ALBERT A. GORE, JR.

Let's Develop the Midgetman Now



AMERICAN strategic military forces rely for survival upon the diversity of the so-called triad—long-range bombers and sea-launched and land-based intercontinental ballistic missiles (ICBMs). Since the late 1960s, there has been growing concern about the possible vulnerability of one leg of the triad—the land-launched missiles—to attack by improved Soviet missiles. The issue has kept U.S. decision making on arms control and modernization in disarray, as specialists, interest groups, and political leaders have contested one another's judgment.

Some analysts believe that this is an overreaction, since no form of Soviet attack, based on present or projected forces, would be capable of destroying enough of our triad to prevent a devastating counterblow. But so far no president has been ready to discount ICBM vulnerability because these missiles are our most responsive and accurate weapons, and the political future is dim for any modernization scheme or arms-control concept that fails to resolve the issue.

The United States has attempted to remedy the situation by negotiating for missile forces that would prevent each side from being able to carry out an effective first strike, and by trying to devise ways to base ICBMs that would be highly resistant to attack. In the case of the 10-warhead MX, between 1979 and 1983 the Reagan administration proposed more than 30 ways to base the missile so that it could survive a first strike. None gained acceptance.

Enter the Midgetman

Finally, with Congress poised to cancel the MX in early 1983, President Reagan asked former National Security Advisor Brent Scowcroft to lead a panel of experts in a review of the problem. That spring, the Scowcroft Commission proposed a new solution: deploying 100 MX missiles in silos, and developing on a crash basis the Midgetman—a light missile, armed with a single warhead, and carried on a mobile launcher hardened against nuclear blast.

The commission reasoned with great persuasiveness that such a missile could resolve a number of interlocking strategic, political, and negotiating problems. First, it would reverse the advantages of a Soviet first strike against our missile silos. Today, Soviet warheads are so accurate that just two would have a high probability of destroying one of our missile silos, which could be holding an MX with ten warheads. A mobile missile system, however, would require that the Soviets barrage the area in which the missile launchers might be found. This would require far more of their weapons than it would destroy of ours. Experts refer to this as a high "price-to-attack."

Moreover, if the mobile launcher were sufficiently hardened to survive nuclear attack, the Midgetman could operate on existing military bases, out of the public's way. So the idea would be much less likely to create local opposition on safety or environmental grounds than if it were dispersed throughout the interstate highway system. That is extremely important, considering the bitter debates about the environmental effects of the principal MX basing schemes.

Finally, Midgetman would help concentrate arms control and modernization on developing mutually stable U.S.-Soviet missile forces. So long as both sides rely on silo-based, multiple-warhead ICBMs, even deep reductions might leave enough warheads on either side to destroy the other's silos. In a crisis, each side might feel compelled to use rather than lose its ICBM force. Only by shifting away from the use of silos and reliance on multiple-warhead missiles can this situation be avoided. Midgetman would do both.

At first there were doubts whether

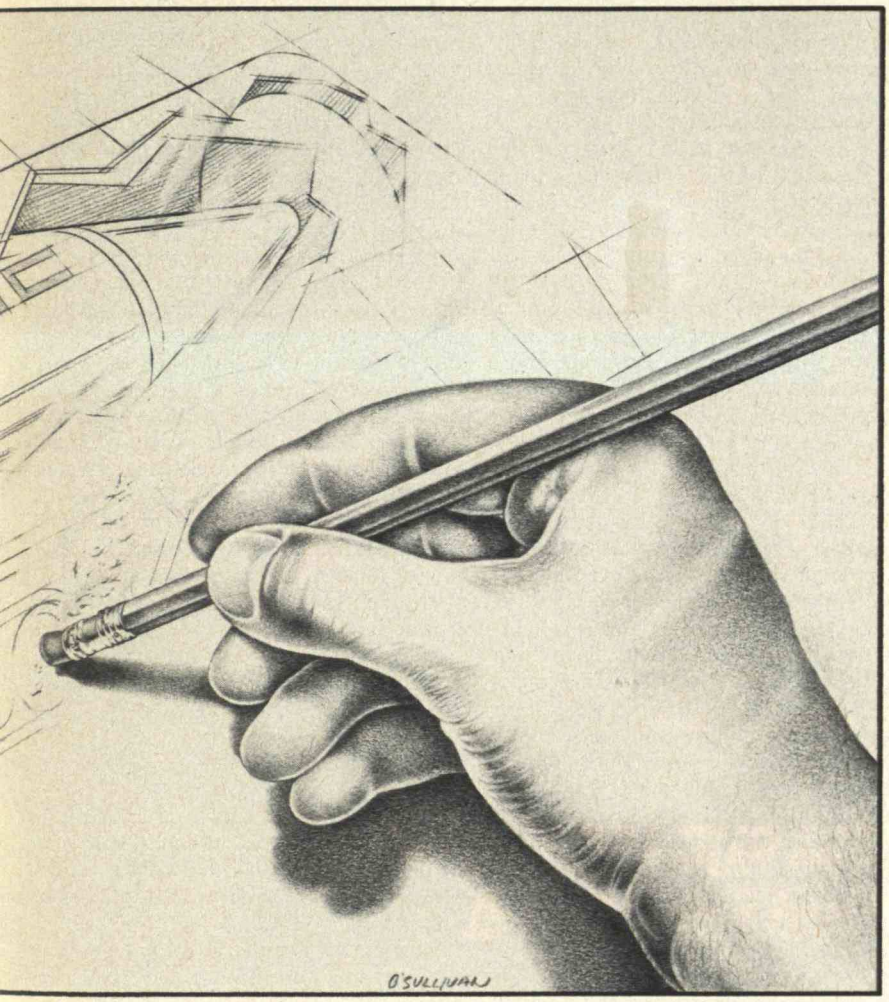
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ALBERT A. GORE, JR. (Dem.), junior senator from Tennessee, serves on the 10-member Senate Observers Panel to the Geneva arms-control talks.

ILLUSTRATION: JOHN O'SULLIVAN

BY ROBERT R. EVERETT

Forget the Midgetman; Build MXs



THE United States is faced with a decision about whether and how to modernize its intercontinental ballistic missile force. The existing force—1,000 silo-based Minutemen, of which 450 have one warhead and the rest have three warheads—was built during the 1960s and 1970s. Many of the missiles will be more than 20 years old before they can be replaced. Since complex devices like these corrode and become unreliable and harder to maintain, we must do something about modernization.

The best way to update the force would be to build a minimum of 100 ten-warhead MX missiles. Some analysts prefer a small, single-warhead missile, unofficially called the Midgetman, that would be transported on a mobile launcher. But the MX, which was proposed by the air force about 10 years ago, would be much less expensive and a superior threat to the Soviets.

When the air force developed the idea of the MX intercontinental ballistic missile (ICBM), the argument for it was unfortunately founded not on the aging of the existing fleet, but on the vulnerability of the silo-based Minutemen to attack by new Russian ICBMs. The debate therefore focused on how to base a new missile so that it would survive. Since then, many basing proposals have been made, but so far all have foundered on the grounds of cost, land use, or questionable survivability.

In the meantime, our Russian adversaries have produced several hundred more ICBMs, including two new mobile versions. They apparently have a policy of steadily improving and updating their strategic forces, and are untroubled, or at least not immobilized, by concerns similar to ours.

In 1983, the Scowcroft Commission, a panel of experts set up by President Reagan to examine the question of modernizing the ICBM force, proposed a compromise. It consisted of threatening the Russian silo-based force by procuring 100 MX missiles—a marginally adequate number—and basing them in Minuteman silos. In addition, the commission proposed developing a single-warhead missile—the Midgetman—to be mounted on a mobile launcher hardened to attack. Finally, the panel suggested that the United States attempt to negotiate an arms-control agreement with the Russians that would enable both sides to give up their multiple-warhead, silo-based missiles. It is not clear why the Russians would want to give up their substantial advantage in silo-based ICBMs, but the Scowcroft proposal was logical and consistent, and aimed at stability. Unfortunately, Congress has thus far failed to go along with a fundamental part of the plan: procuring enough MXs to threaten the Russian counterparts.

Both Hawks and Doves Are Wrong

At the moment, there is much pressure to develop the Midgetman and to maintain the limit of 50 MX missiles that Congress set. Doves argue that the stationary MX increases the probability of nuclear war. Since the missiles may not survive an attack, the United States has an incentive to strike first or launch during a Soviet attack. And the very accurate MX threatens the Russian silos, which gives the Soviets an incentive to strike first. The doves assume that the Midgetman is a stabilizing force because its mobility makes it hard to target and destroy. Many hawks are saying that the battle for the MX is lost, arguing that we should support the Midgetman as the only politically feasible new missile.

I disagree with both positions. It would be a serious mistake to give up the MX without some assurance that the Russians would give up their silo-based forces. It

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ROBERT R. EVERETT is past president and a member of the board of MITRE Corp., a nonprofit defense contractor based in Bedford, Mass. He was a member of the Deutch Committee, a panel organized by the Defense Department's science board to look at the problem of ICBM survivability.

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Midgetman's demanding specifications could be met. Mobility requires light weight, and the Scowcroft Commission set a 30,000-pound goal for the Midgetman, versus the 195,000-pound weight of the MX. The small missile would also need a mobile launcher able to survive a one-megaton explosion as close as one mile away. Yet the launcher would need to be light enough to travel an average of 30 miles per hour in a wide range of weather conditions, even along unimproved military roads and trails. Finally, the lightweight mobile missile would have to be as accurate as the MX in order to be able to destroy hardened Soviet targets.

Solving the Problems

After three years of development, the solutions to these problems are in hand. Advanced materials give the missile's motor casing great strength at minimum weight. Two competing prototypes for the mobile launchers have been delivered to the air force for testing. Both have very good hardness and mobility. And the MX missile's extraordinarily successful guidance system is being modified for use in the Midgetman.

Meanwhile, the assumptions about the Midgetman's ability to increase the number of Soviet missiles needed to destroy our missiles have been reviewed both by the Department of Defense and a panel of outside experts under the leadership of John M. Deutch, provost of M.I.T. Both studies concluded that the system would exact a very high price-to-attack from the Soviets.

If the United States had 15 minutes of warning time in which to disperse the Midgetman missiles throughout their bases, an attack on 500 Midgetmen would require all of the Soviet Union's most modern—"heavy"—ICBMs. With 25 minutes of warning, which is the approximate ICBM flight time from the Soviet Union to the United States, Midgetman launchers could disperse so extensively as to force the Soviets to use all their ICBMs and most of their sea-launched missile force. An advantageous Soviet first strike against our ICBMs would be out of the question.

In August, a study by the Congressional Budget Office weighed the probable effects of an attack on the Midgetman by a much larger Soviet ballistic-missile force than we now face. The study concluded that the Midgetman system, traveling around the military bases currently being considered for this use, could deal with a very large Soviet buildup. Moreover, even a twofold Soviet expansion could be negated, since there is enough suitable land under Defense Department control to double the dispersal area planned for the Midgetman.

Attention has also been paid to exotic forms of attack not now feasible. One of these is a "pin down" attack, whereby Midgetman's dispersal would be cut short by sea-launched missiles flying on a flattened course through the lower atmosphere. They could reach their targets just 10 minutes after being launched from Soviet submarines close to the United States. Another concern is that the Soviets would somehow be able to find, trail, and individually target each Midgetman launcher in real time. A full discussion of such attacks requires classified material, but it can be said that the Midgetman has the means to respond through options that include deception and expansion of its dispersal area.

Ready for Development

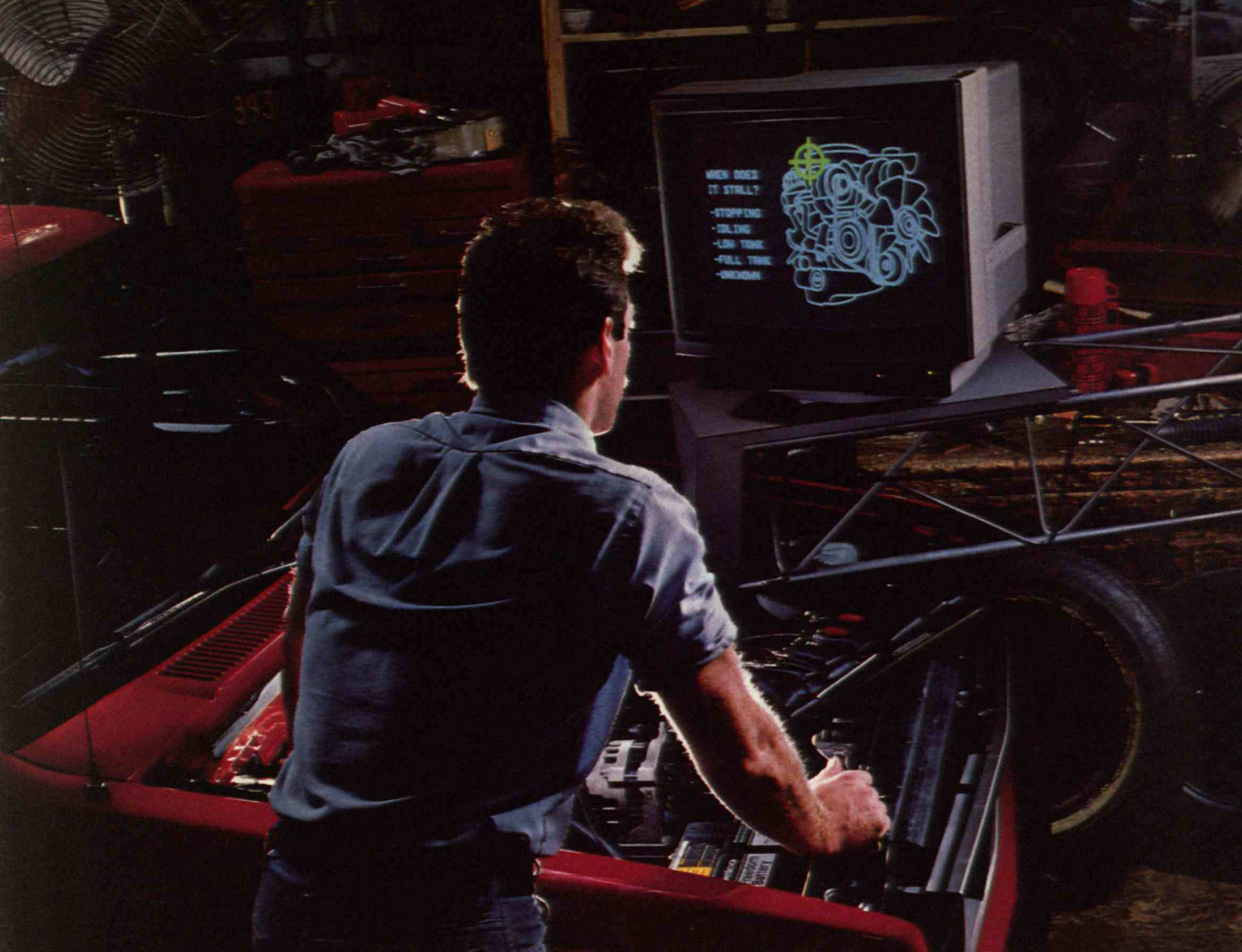
Midgetman is now ready to enter full-scale development. There is no doubt that it can be deployed beginning in 1992, as scheduled, if funds to support that pace continue to be available.

Midgetman commands broad political support, ranging from defense conservatives at the Committee on the Present Danger to arms-control advocates at the Union of Concerned Scientists. Yet the missile's future is not a sure bet.

In November 1985, the administration proposed a ban on all mobile missiles. That would stop the deployment of two new Soviet mobile ICBMs, but it would also kill the Midgetman.

Now there are indications that the administration may be backing away from its proposed mobile-missile ban, but it still does not appear to have grasped the full implications of Midgetman for arms control. The administration does not appear to recognize that the Midgetman could neutralize the Soviet Union's five-to-one advantage over the United States in total missile payload, or throw-weight. Midgetman would effectively even out the situation because of the large number of Soviet warheads needed to attack just this

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CONTINUED FROM PAGE 25

would be an additional mistake to proceed with the Midgetman in its present form if the MX is abandoned. A mobile ICBM would be a fine weapon, but I am deeply concerned about the Midgetman's high costs, both in absolute terms and compared with the MX. The Department of Defense estimates that developing, procuring, and operating 500 Midgetmen would cost about $50 billion in 1986 dollars. That's $100 million per warhead.

The development, testing, and support costs of the MX have already been paid, so those missiles can be bought relatively cheaply. The cost of 50 additional MX missiles, with a total of 500 warheads, placed in Minuteman silos would be about $2.5 billion, or $5 million per warhead. In other words, Midgetman warheads would cost 20 times more than MX warheads.

Midgetman warheads would also cost roughly 20 times as much as the Soviets' multiple-warhead, silo-based missiles. This enormous difference cannot be ignored. We will find ourselves in a very assymetrical position with respect to the Soviets if we buy only the Midgetman: they will have a large number of relatively inexpensive, silo-based, multiple-warhead ICBMs, while we will have a handful of MXs plus a small number of very costly Midgetmen. (It is extremely unlikely that we would ever build the thousands of these costly missiles needed to seriously threaten the Russian silo-based ICBMs.) While our force may be vulnerable if the Russians figure out how to attack mobile missiles, their force will not be. We will have deliberately chosen not to threaten them. This would not be a stable situation, either in terms of continued deterrence or for possible arms-limitations agreements.

Keeping the Pressure on the Soviets

I believe it is absolutely necessary to have enough highly accurate warheads to threaten the Russian silos. The Soviet Union is giving us enormous trouble militarily, technically, politically, and financially by threatening our ICBMs with its silo-based, SS-18 multiple-warhead missiles. Our buying no more than 50 MX missiles not only frees the Soviets from worrying about protecting their silos. It also removes their incentive to give up their multiple-warhead missiles in an arms-control agreement because they would not seem vulnerable.

Moreover, we should be wary of the claim that attacking the MX will be easy and destroying the Midgetman would be difficult. Survivability is not an all-or-nothing matter. An attack on silos, even with highly accurate ICBMs, is a chancy business since so much complex, untested equipment and so many procedures must work the first time. And the harder the silos, the less the certainty of success. Conversely, the Midgetman may have its own vulnerabilities. Mobile missiles, especially in desert areas, may be vulnerable to bomber aircraft and survive only a few hours under attack unless provided with very costly air defenses.

Analysts often assume that vulnerable missiles are not useful since we don't intend to strike first and are not even sure we would launch our missiles under an attack. But the enemy does not know what we might do given enough provocation. This fact encourages the Soviets to spend money on survival. Uncertainty makes the Russians cautious, and in this sense is stabilizing—not the reverse.

The federal budget is tight and will probably become more so. The political system will determine how much will be spent on defense. Allocations within the total limit that Congress sets will be fought over, but the overall military budget will be largely unaffected. This means that money spent on the Midgetman will not be in addition to other expenditures but instead of them. The $50 billion it would cost would buy many items: helicopters, tanks, ammunition, training, attack submarines, and so on. By buying Midgetman missiles we would lose the opportunity to purchase these items.

This goes for the Soviet Union as well. Within its military budget, money spent on ICBMs will decrease the amount available for other items such as conventional weapons, of which it has a large numerical advantage.

I believe that we should stiffen deterrence in the cheapest and quickest way by buying more MX missiles—even more than the 100 that the Scowcroft Commission recommended. We should produce a certain number a year according to a rate we can afford, perhaps 50. We should stop when we reach an arms-control agreement with the Soviets or decide that we have enough MX missiles.

We should also consider more survivable ways of basing the additional MXs. Superhard silos can now be built that are much more difficult to destroy than Minuteman silos. Arranging such superhard silos in a closely spaced array would make it difficult for an attacker to shoot many warheads into the area without having them destroy each other instead of the MX missiles. Such an array could probably be effectively defended using existing terminal-defense technology, perhaps including radars that track warheads and missiles to destroy them. There are also new and possibly cost-effective ideas for deceptive basing, a form of mobility in which the missiles are moved randomly among a number of shelters.

None of these arrangements would be guaranteed to survive—nothing is—but they would greatly reduce an attacker's confidence in destroying the missiles. In absolute terms they would be expensive, but they would cost only a small fraction of what the Midgetman would cost. For example, building superhard silos for 50 MX missiles in a closely spaced array would probably cost less than $10 billion.

Once a sensible MX program is underway, we should begin an orderly program for developing a mobile missile—but not necessarily the Midgetman. Deploying mobile missiles in addition to the MX would present the Soviet Union with another set of attack problems, and would help us negotiate limitations in both sides' mobile missiles. To improve cost-effectiveness, we should reexamine what a mobile missile should weigh, how many warheads it should have, where it should be based, the degree to which its launcher should be hardened against nuclear blast, and how the system should be operated.

Whether or not we build more than 50 MX missiles, we should stop the crash program to develop the Midgetman. The Midgetman is just too costly in its present form.

Some of the current Midgetman supporters are not really supporters. Instead, they are using the proposed missile to kill the MX. Once the MX is safely dead, they will suddenly discover the small ICBM's high cost and will turn into opponents. The apparent consensus will disappear.

The MX is now; the small, mobile ICBM is later. If we focus on the Midgetman, in the 1990s we may find ourselves with another $10 billion of R&D money and many years wasted, and nothing accomplished. It would be far better to spend this money on other strategic systems that make sense militarily and financially as well as politically. □

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We must change our water policies so that the cost of this resource reflects its value.

WATER

Not as Cheap as You Think

HUMANITY uses a little less than half the water available worldwide. Yet pockets of shortages and droughts are causing famine and distress in some areas, and industrial and agricultural by-products are contaminating water supplies. Since the world's population is expected to double in the next 50 years, many experts think we are on the brink of a widespread water crisis.

But that doesn't have to be the outcome. Water shortages do not have to plague the world—if we start valuing water more than we have in the past. Just as we began to appreciate petroleum more after the 1970s oil crises, today we must start looking at water from a fresh economic perspective. We can no longer afford to consider water a virtually free resource of which we can use as much as we like in any way we want.

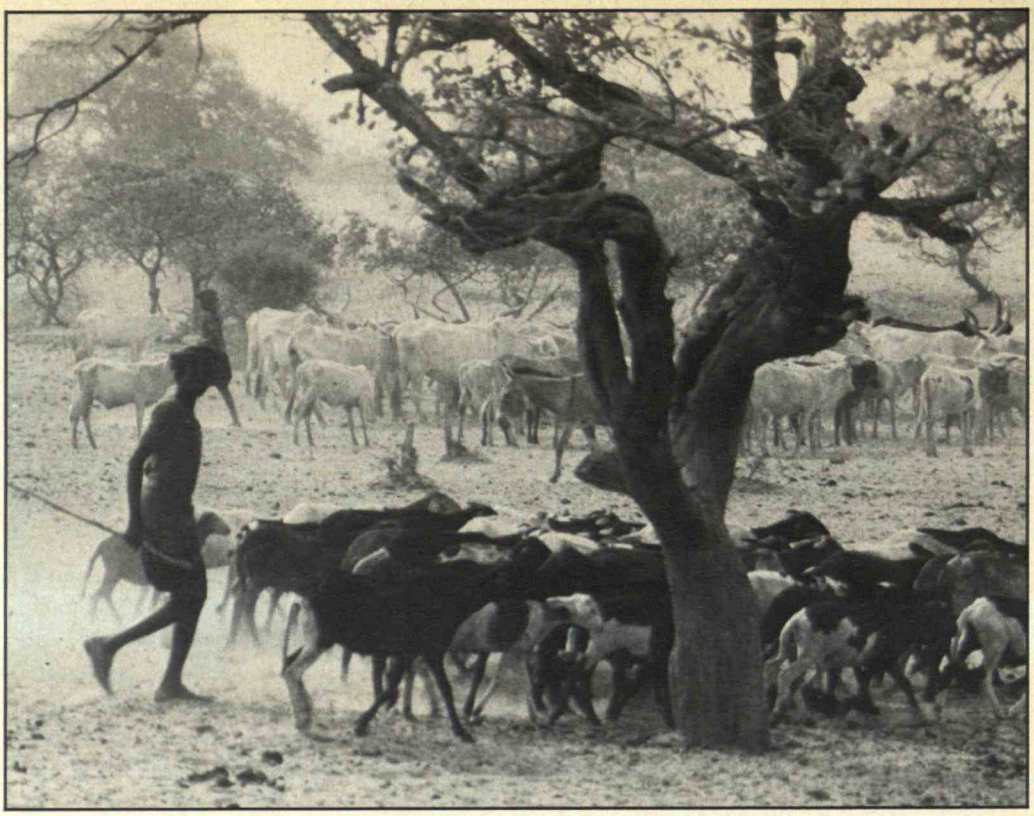
Instead, for all uses except the domestic demands of the poor, governments should price water to reflect its actual value. This means charging a fee for the water itself as well as for the supply costs.

Governments should also protect this resource by providing water in more economically and environmentally sound ways. For example, often the cheapest way to provide irrigation water in the semi-arid tropics is through small-scale projects, such as gathering rainfall in depressions and pumping it to nearby cropland. Constructing large dams, on the other hand, often causes large-scale environmental damage and is more expensive than the use justifies. In fact, it is not economical for all regions to irrigate. Some countries would do better to import food than to undertake very expensive water projects.

PETER ROGERS

PHOTO: DEWITT JONES, WOODFIN CAMP & ASSOC.

Many areas can count on receiving less than half their annual average water supply in any one year.



No matter what steps governments take to provide water more efficiently, they must change their institutional and legal approaches to water use. Rather than diffuse control among hundreds or even thousands of local, regional, and national agencies that oversee various aspects of water use, countries should set up central authorities to coordinate water policy. Even some of the driest, poorest countries that have recently had significant population increases, such as Chad, Mali, and Kenya, could supply more water to their people if they changed some of their approaches to managing water.

Water, Water Everywhere

How much water is available around the world? Soviet geographer M.I. L'vovich, who has done the most comprehensive studies in the last two decades, estimates that total annual global precipitation is about 126,000 cubic miles. That's some 44,000 times the annual average flow of the mighty Colorado River at Yuma, Ariz. Unfortunately, 78 percent of this precipitation, or almost 99,000 cubic miles, falls over the oceans and cannot be readily used. Of the remainder, 64 percent evaporates, leaving only 10,000 cubic miles available each year as surface runoff or groundwater. Most of that runs directly to the sea during floods; rivers and reservoirs can be counted on to store just 3,000 cubic miles. Realistically, that amount should be whittled down even further to 2,000 cubic miles, since 1,000 cubic miles are available only in sparsely inhabited regions of the world.

But this global picture does not tell the whole story, for water is not always a reliable commodity. Some regions may experience droughts for years, or seasonal dry spells followed by heavy rains. Cherrapunji, Assam, in eastern India, for example, recorded 22 meters of rainfall in a year. Yet no rain fell in one 14-year period at Iquique in the Chilean desert. Many areas can count on receiving less than half their annual average water supply in any one year.

Most experts base their estimates of how much water is available on annual precipitation and water flows. However, the amount of water available also depends on how much people are willing to pay for it—which is determined by its scarcity. For example, in the Middle East much more water has become available since the 1950s because people have been willing to pay up to ten times more for it than residents of wetter climates. In that arid region, water is properly considered a very scarce resource, and people have traditionally had limited water supplies. But as money has been pumped into the area, many countries have financed major water-supply projects. Saudi Arabia, for example, has built extremely costly plants to desalinate ocean water. Libya is spending billions to pump out "fossilized" water that was deposited tens of thousands of years ago under what

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is now desert. This water is expected to be transported to Tripoli and coastal Libya beginning in the early 1990s via a huge pipeline now under construction.

Consumers in areas where water is more plentiful treat it as if it were virtually free, with plenty for all. Indeed, adequacy of the water supply has historically been a major component in the decision of where to locate a town or industry. As a result, most cultures do not assign a cost to the water itself, in addition to charging for storing, transporting, and treating it.

This omission obscures the competition that exists for water. In addition to basic human needs for water, practically all industries rely on the resource. It is used to produce electricity and to dispose of wastes. And there could be no agriculture without water. In fact, far more water is used for agriculture than for any other purpose today. In the United States, for example, agriculture accounts for 83 percent of the total annual water consumption. Unfortunately, farmers often use water very inefficiently, and governments frequently encourage these wasteful practices by subsidizing the cost of irrigation.

For example, through its Salt River project, the U.S. Bureau of Reclamation supplies water to farmers in the Phoenix, Ariz., area for highly subsidized rates—as little as $8 per acre-foot (the amount needed to cover one acre a foot deep, about 325,000 gallons). City residents and industries would gladly pay much more, since the public water utility will soon have to expand the municipal water supply at a cost of more than $300 per acre-foot. But the federal government granted farmers access to cheap water to encourage farming long before Phoenix became part of the Sunbelt boom.

The uncoordinated policies of myriad water agencies also result in inefficient water use. Few countries have clearcut policies concerning water use and pricing, the most effective means of promoting conservation. Agencies often set water prices according to political expediency rather than the costs of supplying it. The United States, for example, has at least 27 federal agencies involved with water authorities in every state, more than 59,000 water-supply utilities, and thousands of county and local organizations. Some oversee various kinds of actual water use, while others focus on the origins of the water supply, such as rivers or the ground.

Slipshod organization is also common in other countries. In India, the use of surface water is administered by the Central Water Commission, while the Central Groundwater Board oversees groundwater use. There is little practical integration of these agencies' plans, despite a formal agreement to cooperate. Each of India's 18 states also has its own department of irrigation, which usually deals only with surface-water supplies, while other departments focus on groundwater. In cities, municipal water is a local responsibility, but many individuals also sell water in small quantities to households. Rural households are almost always in charge of obtaining their own supplies. The result of such compartmentalization is that agriculture, industry, and municipalities use water inefficiently.

PHOTOS: UNITED NATIONS, WORLD BANK

World trade can redistribute water in the form of grain to nations that decide not to grow it.

Mishandling Irrigation Prices

Consider how several water management agencies have mishandled the pricing of irrigation water:

In the Sierra foothills near Sacramento, Calif., stands the partially built Auburn Dam, conceived by the U.S. Bureau of Reclamation in the 1960s and expected to cost $200 million to $300 million. In 1980, that agency proposed to average the cost of the water from the Auburn Dam with the cost of the rest of the water it supplies to area farmers. That would mean charging about $18 per acre-foot, even though the actual cost of the water supplied by the new dam is expected to be about $200 per acre-foot. One can justify irrigating almost any crop at $18 per acre-foot, but no crops can be grown economically at $200 per acre-foot. Construction was halted on the dam in 1984 after public protest at subsidizing such projects.

Today, the Bureau of Reclamation is looking for outside partners to share the dam's cost. If the project is finished, the water will likely sell at $200 per acre-foot—not to farmers but to municipalities, which should find that an attractive price since individuals need much less than farms. The bureau had to obtain special permission from its commissioner to reallocate the water for domestic and industrial uses.

In the Indian state of Bihar, the charges for the irrigation water that comes from river diversions and dams are so low and the attempts to collect the fees so feeble that the irrigation department is in serious financial difficulty. In 1979, efforts to collect fees for water cost 117 percent of the actual amount collected. The irrigation department has had to defer maintenance because of low returns, and the water system has deteriorated. Farmers have less incentive to pay for poor service, and a vicious circle has developed. Moreover, the low water charges have led farmers to use water inefficiently.

By contrast, in both the Punjab region in India and in areas of the United States that rely on water from private wells, farmers are far more conservative in how much they use because they pay higher prices. (Well water costs more because it is not subsidized.) Yet these farmers' crops aren't doomed to failure. When the cost of pumping in the Punjab increased in the 1960s, farmers began growing more water-efficient crops such as high-yielding wheat and cash crops such as cotton, tobacco, and oilseeds.

Such crop reallocations could benefit arid regions around the world. There is no reason why every country should grow grain, which requires, per ton, 2,000 to 3,000 tons of water. Where there is comparatively little water, it can have much higher value for other uses.

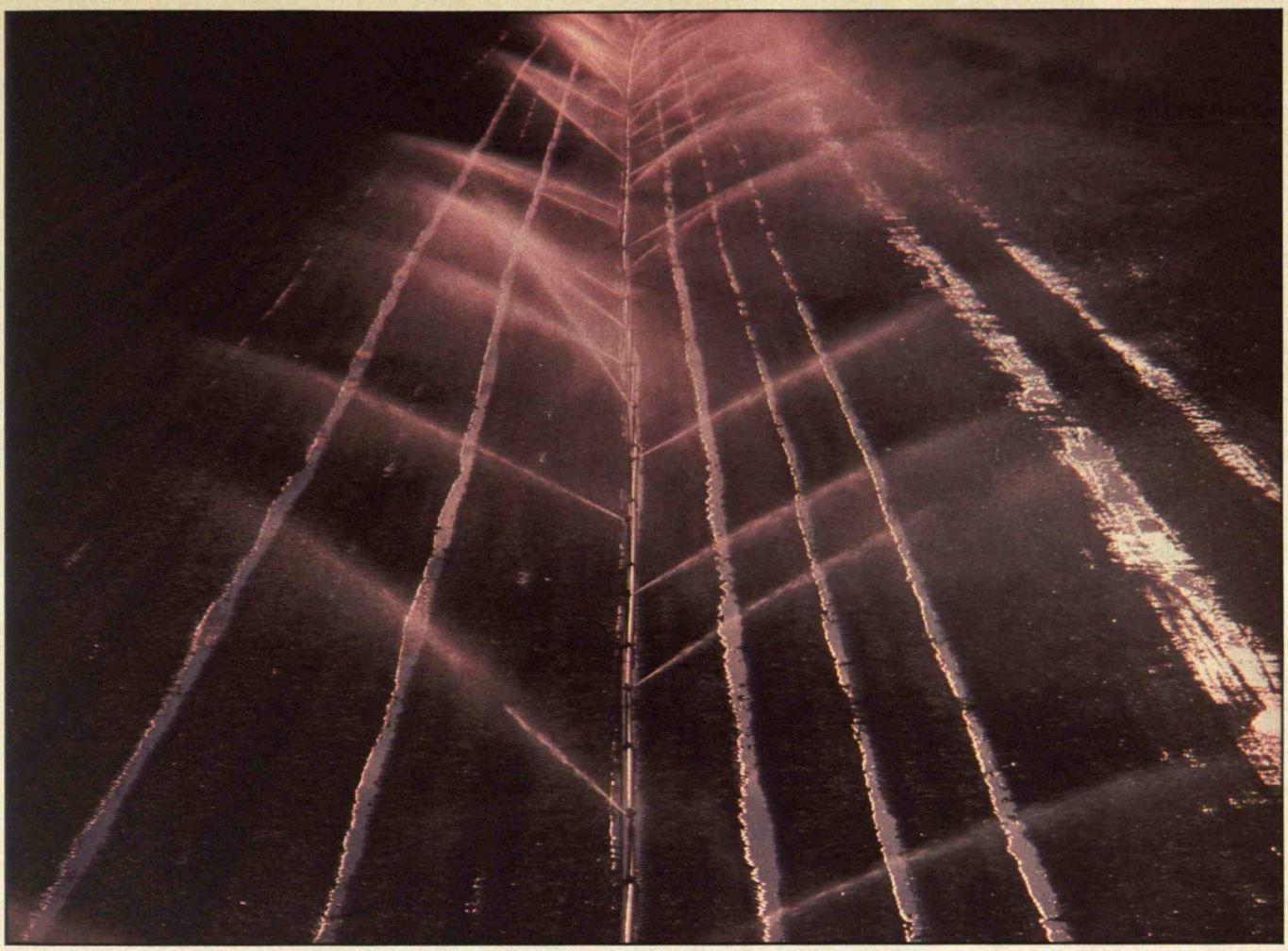
International trade can redistribute water—in the form of grain—to nations that decide not to grow it. Israel subscribes to this practice, emphasizing valuable cash crops such as fruits, vegetables, and flowers for the European market. Countries that take this approach should maintain stockpiles of the basic grains, since even though these are costly and can deteriorate, replacing spoilage is less costly than growing grain. Such nations should grow a diversity of cash crops so changing prices cannot devastate their economies.

In addition to changing the crops they grow, farmers who pay high prices for water regulate the amount of water they use, depending on the times when their crops need it most. They build catch pits to collect and recycle the run-off from irrigation systems. Some farmers in the Punjab even use lasers to level their fields so water won't collect in puddles. In some cases farmers who employ more efficient watering mechanisms save so much of the resource that they can grow water-intensive crops such as rice in addition to their other crops.

The efficient watering technologies available to farmers include drip, center-pivot, and spray systems. In drip irrigation, water flows through an underground plastic pipe to an outlet near the root zone of each plant. Crops usually absorb more than 90 percent of the water in this system, which is most useful for crops spaced far apart, such as grapes. More than 70 percent of the South African grape crop is irrigated in this manner.

Center-pivot irrigation systems consist of large pipes that rotate on wheels at ground level, spraying water downward in large circles up to a half-mile in diameter. Center-pivot systems, which reach efficiencies of more than 70 percent, have turned many areas of the Libyan desert green. Spray irrigation systems spread water directly onto crops from stationary nozzles at or above the plants' level. Plants can use 60 percent to 75 percent of the water applied this way.

Flooding, one of the most widely used irrigation systems in the Third World, is typically much more wasteful than other techniques. While flood irriga-

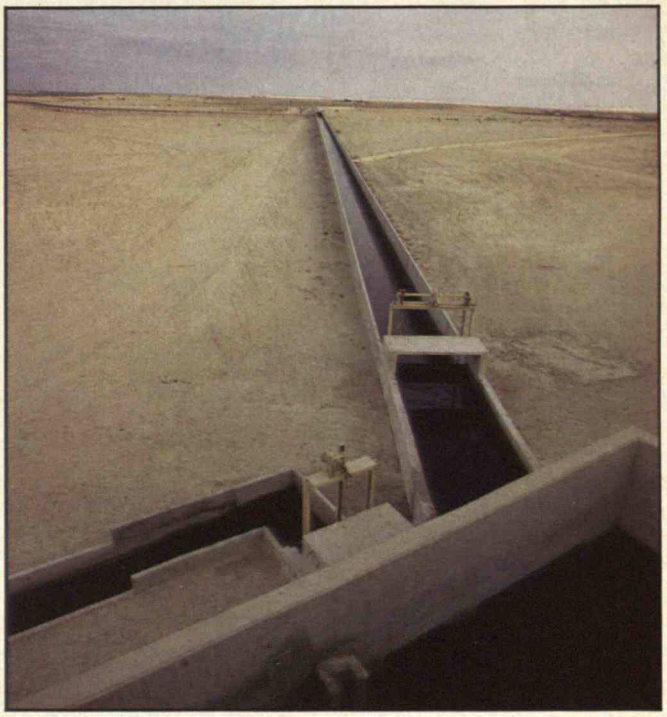


tion can work very well on level fields and with crops such as rice that need plenty of water, plants often use as little as 30 percent of that supplied. In furrow irrigation, another common and wasteful technique, water is sent through furrows between the crops. In this case the plants absorb as little as half the water.

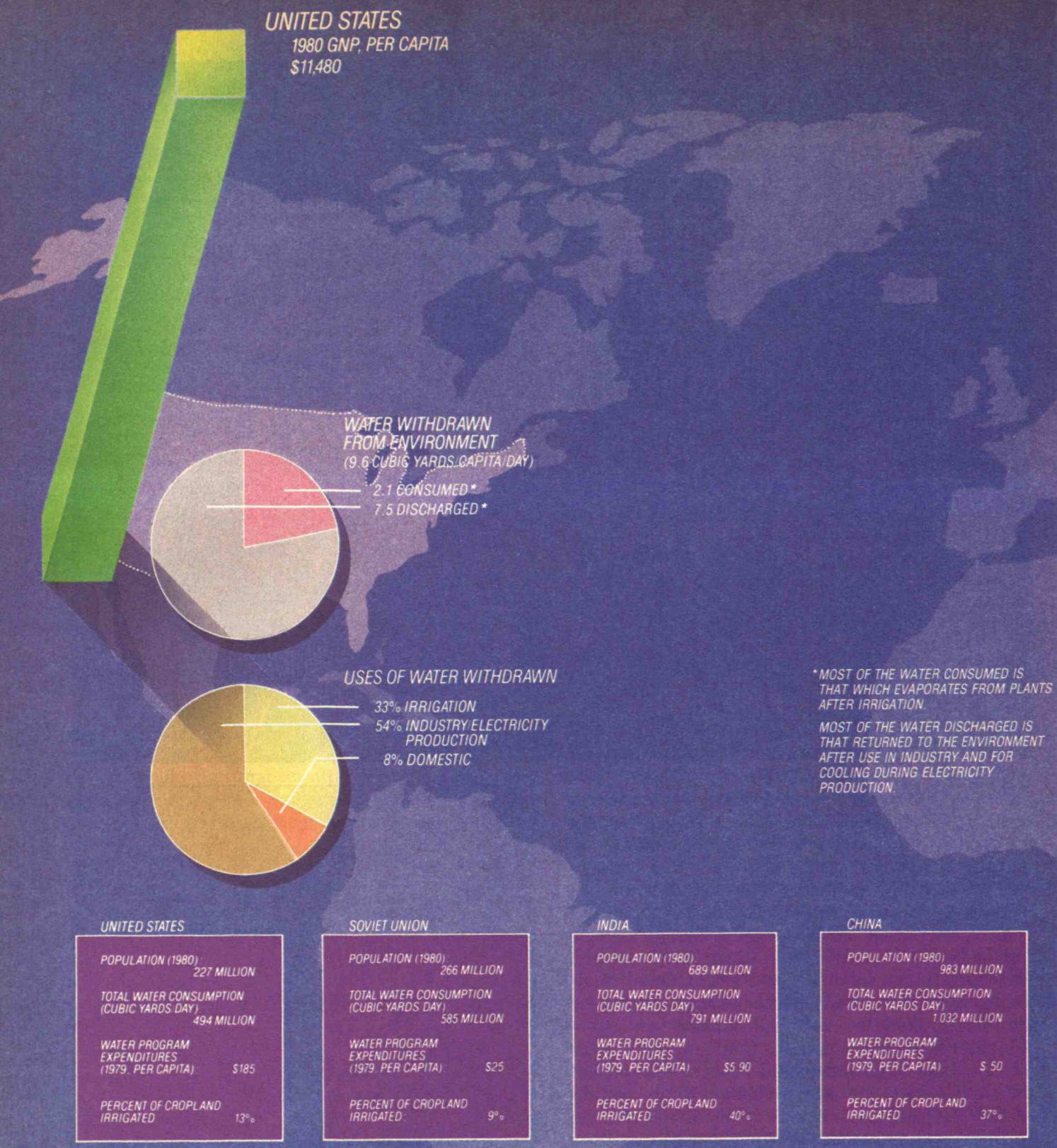
No matter what technology is available, farmers should not necessarily irrigate their crops—despite what government planners and international funding agencies often think. Recent data collected by the World Bank on nine sub-Saharan nations—Kenya, Ethiopia, Somalia, Chad, Niger, Upper Volta, Mali, Mauritania, and Senegal—show that the capital costs for large irrigation dams and diversion projects are too expensive for the returns. Farmers in these countries would need to produce about three tons more wheat and rice per irrigated acre than per unirrigated acre to justify the project investments, a highly unlikely increase. These costly engineering projects probably would not be attractive even to help farmers produce other cash crops.

Such a situation presents a development problem without an easy answer. Countries that don't produce all their food have to buy it, but that requires income, which rural countries generate through ag-

Continued on page 39



Top: Spray irrigation in Colorado. This technique is typically less wasteful than flooding crops. Bottom: A Saudi Arabian irrigation system contrasts with the desert. Irrigation in dry areas is often best used for crops more valuable than grain.



UNITED STATES	
POPULATION (1980)	227 MILLION
TOTAL WATER CONSUMPTION (CUBIC YARDS/DAY)	494 MILLION
WATER PROGRAM EXPENDITURES (1979, PER CAPITA)	$185
PERCENT OF CROPLAND IRRIGATED	13%

SOVIET UNION	
POPULATION (1980)	266 MILLION
TOTAL WATER CONSUMPTION (CUBIC YARDS/DAY)	585 MILLION
WATER PROGRAM EXPENDITURES (1979, PER CAPITA)	$25
PERCENT OF CROPLAND IRRIGATED	9%

INDIA	
POPULATION (1980)	689 MILLION
TOTAL WATER CONSUMPTION (CUBIC YARDS/DAY)	791 MILLION
WATER PROGRAM EXPENDITURES (1979, PER CAPITA)	$5.90
PERCENT OF CROPLAND IRRIGATED	40%

CHINA	
POPULATION (1980)	983 MILLION
TOTAL WATER CONSUMPTION (CUBIC YARDS/DAY)	1,032 MILLION
WATER PROGRAM EXPENDITURES (1979, PER CAPITA)	$.50
PERCENT OF CROPLAND IRRIGATED	37%

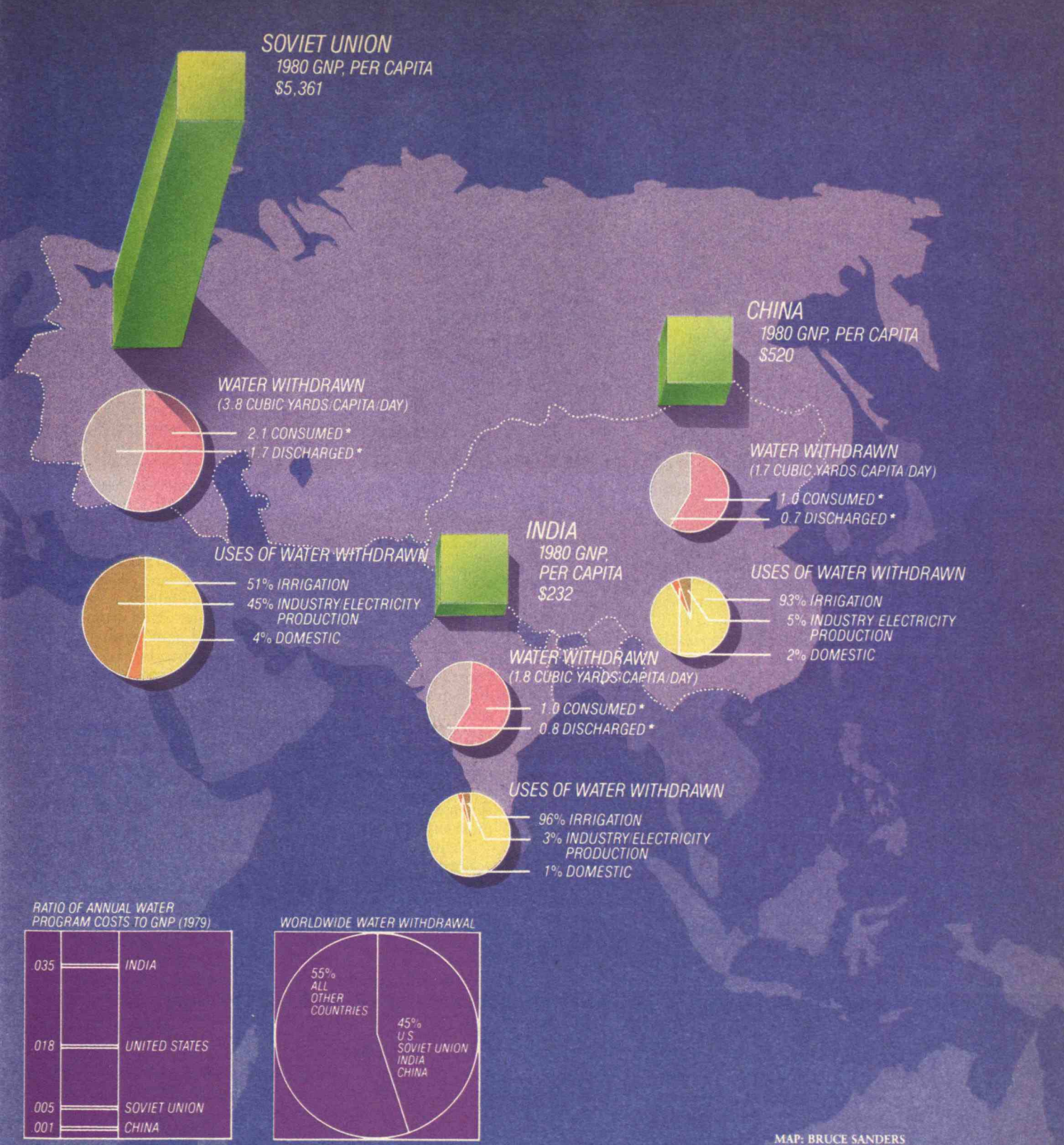
The World's Largest Water Users

THE press often focuses on severe water shortages in small countries such as Mali, Chad, and Niger. But it makes more sense to examine the four countries that contain the bulk of the world's population and land area, since each of these nations—China, India, the Soviet Union, and the United States—also faces water-supply and wastewater disposal problems. Together these countries account for 49 percent of the world's population and 70 percent of the globe's irrigated land.

The level of affluence seems to determine the types of water problems a country can expect. As per capita GNP increases, a country finishes developing the infrastructure for delivering irrigation water and spends more money on controlling water pollution and, to a lesser extent, on developing municipal water supplies. And its water use increases. The United States, for example, withdraws more than twice as much water per person as the Soviet Union, and five times more than either China or India.

These are the major water problems faced by China, India, the Soviet Union, and the United States:

☐ China, with the world's largest population, has a very small amount of cultivated land per capita—about one-



MAP: BRUCE SANDERS

third of an acre, compared with about one and three-quarters acres in the United States and more than two acres in the Soviet Union. So the Chinese government's water policies focus on maintaining and developing the country's irrigation and flood-control systems. The Chinese have been cautiously increasing their irrigation capacity through low-cost, small-scale projects like wells.

The water demands of industries and municipalities are limiting the expansion of irrigation supplies from groundwater, however. So now China is debating whether to build a $20 billion dam that would transfer water from the Yangtze River basin to the Yellow River basin. This dam would be the world's largest, and would have enormous environmental consequences. As many as 3.3 million people would have to move from the area, and diverting the world's most silt-laden river would cause major silting and erosion problems, including the blocking of upstream irrigation canals. Downstream bridges could collapse because of erosion around their abutments.

China faces another problem in the vicinity of Beijing and Tianjin, where more water is being drawn from the ground than is replenished by rainfall. In some places the underground water level is dropping as much as 12 feet

Continued on next page

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a year because of the extensive pumping for irrigation and industrial uses. This can't continue for very long. Not only does pumping become very expensive as water supplies are depleted, but in areas with clayey soil the land can start sinking.

Beijing and Tianjin will also need to spend substantial amounts on water treatment soon, since the amount of polluted water they generate has increased 2,900 percent in 30 years. Shanghai is also beginning to suffer from severe water pollution.

China is experiencing very rapid increases in domestic water demand. In 1978, Beijing residents used 40 times more water for domestic purposes than in 1949. Sharp increases in per capita income have led to the use of more appliances, which in turn has raised the average consumption to about 38 gallons per person per day. Concerned officials are trying to control demand by raising prices.

Of the four countries, China's water-management efforts appear to be the best organized because its per capita expenditures for water programs are relatively low. But that is partially a function of China's accounting system. Two years ago, for instance, the construction of a three-and-a-three-quarter-mile water tunnel was counted as a defense expenditure instead of a water program.

□ India faces the major task of improving the efficiency of its water system. The country is spending about twice as much on water-resource programs relative to GNP as the United States. India, with the world's second-largest population, also has not been able to obtain high yields on its irrigated fields. In the late 1970s, it was producing less than one ton of crops per irrigated acre—less than half the amount grown by the Chinese on their irrigated land. The Indian government's planning commission has blamed this poor showing on delays in completing irrigation projects, and on farmers who overwater and waste the resource. Also, India's irrigation systems, which are based on river diversions, store very little water. Hence, the least amount of water is available during dry spells when water demands are highest. Where possible, it would be better to store water underground.

Despite better crop yields on land irrigated with water from relatively small private wells, Indian state governments are committed to developing large reservoirs and public well systems. Such investments have not proved effective in the past because of their large capital costs and, more important, failures in public management. And India plans to almost double the amount of irrigated cropland by early next century.

That effort would not be needed if the nation improved its current irrigation works. The amount of water available would stabilize if groundwater were pumped into canals before the monsoon season, so that the ground could soak up more water during monsoons. Also, insuring timely delivery of water to all farmers and increasing water charges would help double production on existing irrigated land. If the water system does not become more efficient, by 2005 all available surface and groundwater resources will have to be devoted to irrigation.

Today India spends most of its water budget on irrigation supplies. But the country also needs to improve its domestic water supplies for a population expected to rise to a billion people by the turn of the century. Currently, not enough clean water is available for the population. Water contamination from leaky sewers and dirty storage vessels is a serious problem in New Delhi, Bombay, Calcutta, and other cities. So far, the costs of conventional waste treatment have been too high to justify the expenditure compared with other public projects. This will have to change in the near future, however. Bombay is already involved in an ambitious wastewater-treatment program, involving collection and primary and secondary treatment.

□ Although the Soviet Union is endowed with more precipitation than any country except Brazil, 80 percent of its people live in areas that receive just 40 percent of the water. The country's grain production is uneven from year to year. Plus, as much as 40 percent of Russia's irrigated land may be contaminated by salt, owing to poor management of soils with naturally occurring salt beds. Crop yields on salt-damaged soil are less than a third of those on well-managed soil.

To prevent massive salt concentrations deep in the ground, farmers have to place terra cotta drains under their fields, with attached pipes leading to rivers. This doubles the cost of irrigation systems.

The Soviet government has recently halted several major irrigation projects that would have reversed the direction of three major Siberian rivers to send more water south to grain-producing central Asia. The projects, conceived as a way to increase crop production, were stopped primarily because of their costs. The largest diversion would have cost an estimated $30 billion to $40 billion. There was also outcry among Soviet scientists about such environmental effects as temperature changes and nutrient losses in the Arctic Ocean.

Industrial and domestic water pollution is also becoming severe in the Soviet Union. But the country has allocated only a small percentage of its total water budget to deal with the problem.

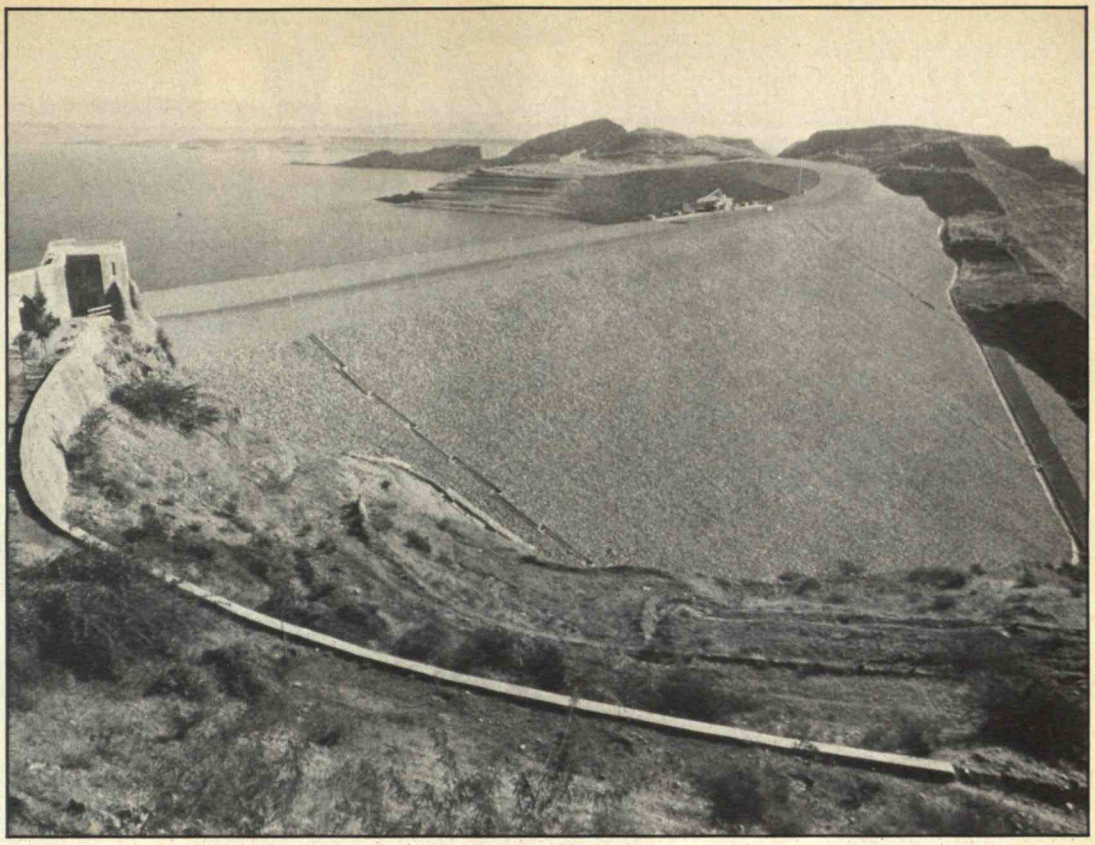
□ The United States is the only one of the four nations that does not have to worry about increasing irrigation supplies. By the mid-1970s, it had more than twice the irrigated cropland it will need for domestic and export agriculture in the year 2000, according to an estimate by Iowa State University's Center for Agriculture and Rural Development.

The United States actually needs to reduce its amount of irrigated land, since farmers draw 20 billion more gallons of water daily from underground aquifers than can be replenished by rain. This situation cannot continue for long. Indeed, some farmers on the Texas high plains above the giant Ogallala aquifer have already stopped irrigating their crops, since the cost of pumping from the declining water table has become too great. They are returning to ranching or growing crops that need less water, such as dryland wheat.

Of the four countries, the United States has the most serious water pollution problems. Nearly half the water discharge is polluted with human or industrial wastes. The remainder is polluted with waste heat, which, depending on where it is released, may cause environmental problems. Indiscriminate chemical-waste dumping has contaminated some aquifers, a problem concentrated in older industrial areas in the East. Recently, almost 60 percent of the nation's water expenditures—$185 per capita in 1979, or more than that year's per capita GNP in India—has gone to clean wastewater. Affluence and effluents go together!

—*Peter Rogers* □

As an alternative to building large dams, water can be stored underground in the soil.



riculture. Their best option is to use many inexpensive, small-scale irrigation techniques, such as small pumps that can provide irrigation for one or two farms apiece, to grow as much food as possible. Investing in expensive irrigation projects such as pumping systems that service hundreds of farmers only makes the economic situations of very poor nations worse.

Increases in water prices affect users differently depending on the original water price. In 1970, B. Delworth Gardner of the University of California at Davis estimated that a 10 percent water price increase in California's San Joaquin Valley would cause only a 5 percent decline in water use when the original price was $4 per acre-foot. But in areas of California where the water initially cost $17 per acre-foot, a 10 percent price rise the same year would result in a 20 percent drop in use.

Cooling Off Industrial Use

Industry uses only 5 to 10 percent of all water supplied but still represents an important segment of demand. That's partly because industrial processes pollute a disproportionate amount of water. In Sao Paulo, Brazil, and Seoul, South Korea, for example, industrial pollution has turned many streams and rivers into open sewers. Developing countries should learn from the experience of the United States: it is much more expensive to clean up polluted water than to avoid polluting in the first place. Nations should charge industries for treating effluents so companies will have an incentive to control their pollution.

Partly because of water-pollution regulations that took effect in the early 1970s, U.S. industry was recycling its water an average of 2.2 times by 1975, and West German industry had a similar recovery rate. Japanese industry, which was subject to fewer penalties for pollution, used its water only 1.5 times before returning it to the environment. U.S. industrial recycling rates would improve even more if prices for industrial water, much of which comes from municipal taps, also rose.

Most electric utilities, which are major industrial users, use their cooling water inefficiently because they obtain it free except for the cost of pumping it from an ocean or river. Consider what would happen if a typical U.S. utility had to pay more for this water. If the water itself were priced at a penny or less per 1,000 gallons, the plant would employ "once-through" cooling, which uses 50 gallons for every kilowatt-hour of electricity produced. If the price increased to 5 cents per 1,000 gallons, the utility would build a cooling tower, which would require just 0.8 gallons of water for each kilowatt-hour of electricity. Thus, a fivefold price increase would lead to more than a 50-fold reduction in water. If the price of water rose to $8 per 1,000 gallons, the utility would use a dry cooling tower, which is a closed-circuit water system that uses a condensor to cool air mechanically. The price of electricity from plants



Only a small percentage of the world's rural population has adequate clean water supplies and waste-disposal facilities. Near right: People bathe in the River Ganges in India. Center: In 1973, when Senegal had been experiencing a drought for five years, water demand was great at one of the few active wells left in the Sahelian desert. Far right: A girl draws water from a new pump in the Congo.

with cooling towers would rise only slightly.

Joseph Harrington of the Harvard School of Public Health has documented more efficient water use by several industries in Sao Paulo in response to price increases. The industries, including pharmaceutical and food-processing companies, reduced their demand for water by 40 percent when the water utility started charging for treatment.

The ability to make such sharp responses to price should make industry extremely cautious when projecting its water "needs." If countries raised industrial water and wastewater charges, more industries would adopt innovative technologies such as dry cooling towers, and would use low-quality saline or reclaimed sewage water for cooling purposes rather than drinking-quality water.

Cutting Household Demand

Researchers have found that in a number of countries—Israel, Canada, Great Britain, and the United States—household water demand drops by 3 percent to 7 percent when prices rise 10 percent. But too often water authorities set prices that are as low as possible—usually according to the average cost of supplying the water from a variety of sources.

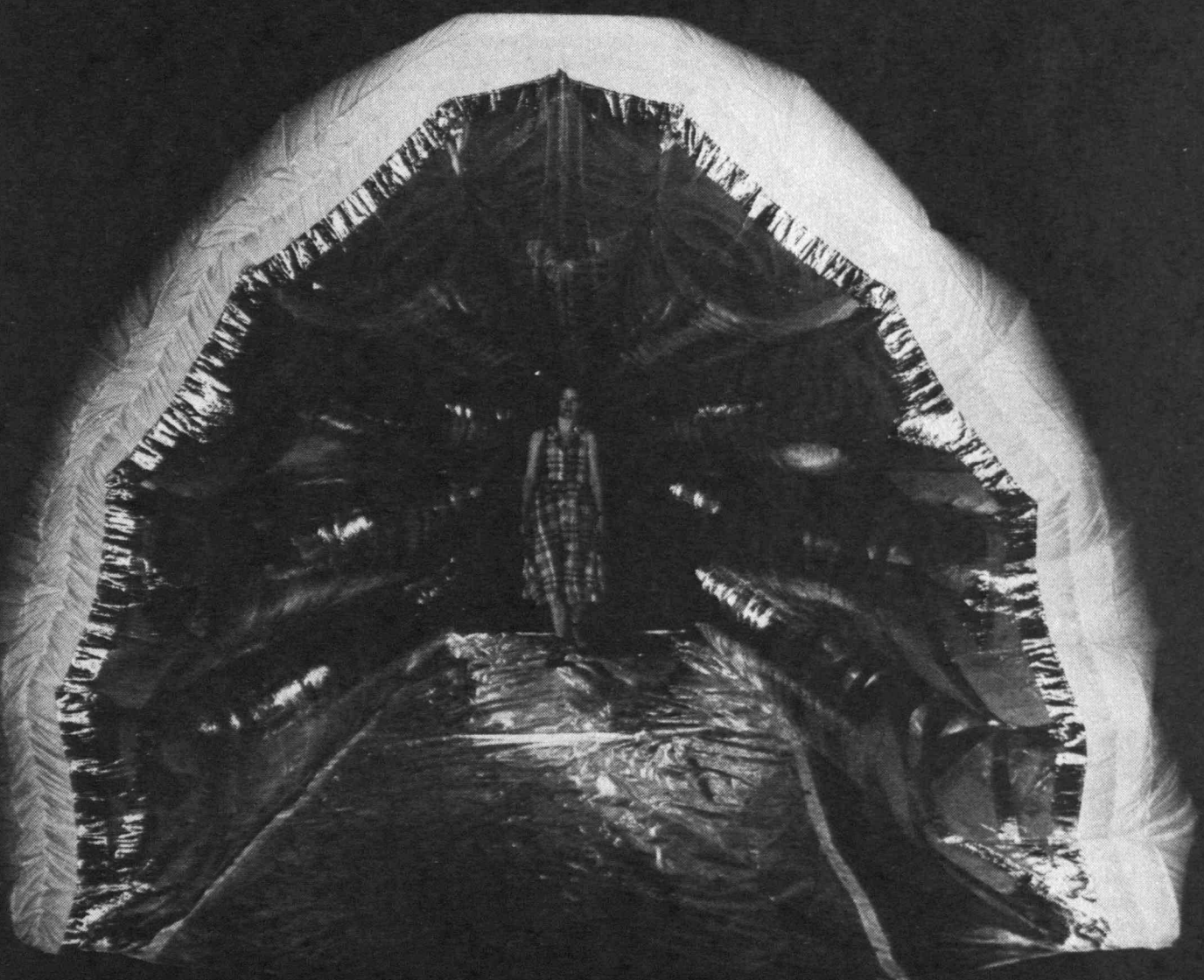
Water would be used far more efficiently if it were priced according to the cost of producing it at the newest dam or other supply source. This would also indicate how much customers really wanted additional supplies in the future. Since the water from older sources would not cost that much to produce, the utility could return the windfall profit to the community in an annual lump sum. No municipality has yet switched to this kind of pricing, but some, including Tucson, Santa Fe, and Denver, have saved significant amounts of water by increasing domestic water charges somewhat above the average cost of supplying it.

Water meters also limit domestic demand because consumers are more conscious of how much they are using, and therefore how much they are spending. During a 13-year study in Boulder, Colo., metered households used up to 49 percent less water on their lawns than those without meters who paid flat fees. Bans on lawn watering and car washing usually do not reduce domestic water use permanently. Bans, which are typically imposed during droughts or peak demand periods in summer, reduce domestic water use by about 15 percent, but consumption levels rise again after the bans are lifted.

Many developing countries restrict household water use by supplying it intermittently throughout the day. However, when the pressure on the distribution system drops, water from outside the pipes leaks in, adding bacterial and other contamination. Another problem is that wealthy customers often build storage systems on the roofs of their homes. These increase demand when water is available and are another source of contamination. The result: even if a city provides its residents with high-quality water, they end up using heavily contaminated and poten-

MIT

NOVEMBER/DECEMBER 1986



"I WAS WALKING ACROSS THE CAMPUS, AND I FOUND THIS THING . . ."

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ABOUT THE COVER
Kidding aside, graduate student Lees Ruoff did not "find" this environmental sculpture; she designed it for the 1986 Sky Art Conference, held at M.I.T. She sees her inflatable as a "transitory passageway" that "can change our experience of indoor or outdoor areas." (Photo: L. Barry Hetherington)

One of the Greatest Pranks in History Revisited

by Robert W. Baldwin, '79

The winner of the 1982 Harvard-Yale game was M.I.T.

That nonsequitur was born just four years ago on the eve of that annual classic, when the M.I.T. Chapter of Delta Kappa Epsilon buried a balloon and a remotely-controlled inflator under the playing field of Harvard Stadium. The device functioned perfectly, and the balloon emerged in the middle of "The Game" to become one of the greatest hacks in M.I.T. history.

The facts behind legends fade quickly, so two years ago I decided to interview some of the students who worked on the hack. I soon discovered that amazing efforts of planning and execution stood behind the stunning surprise in Harvard Stadium on November 20.

DKE had originally planned the hack for the 1980 Harvard-Yale game, and the first version of the inflator was built during the fall of 1980 by a mechanical engineering student who prefers to remain anonymous. But when this device was finally finished, DKE didn't have time to complete the rest of the system and bury it at Harvard. The idea was abandoned and almost forgotten.

Two years later two members of DKE overheard a Harvard student talking at a Wellesley party about the upcoming big game. They remembered the balloon device and went to work. That meant three major efforts: scouting out the stadium, completing the system, and—trickiest of all—installing it, all in complete secrecy. Only the fact that the 1980 inflator was still available made it possible to have a device working, tested, and ready by kick-off time.

As finally assembled the device was complex. It had two power systems—an electric vacuum cleaner motor and fan to inflate the balloon, and a tank of compressed freon to lift the fan assembly out of the ground.

In the course of three nights, DKE scouted out the stadium and Harvard's security measures. They found no trouble in climbing the fence. Though the field itself was not lit at night, stray light from the rest of the athletic complex did provide dim illumination. The conspirators realized that anyone in the parking lot adjacent to the open end of the U-shaped stadium could see a saboteur on the field. So a guard had to be posted.

A power source was easily found—an electrical box inside the west leg of the stadium. The toughest problem turned out to be running a cable from the power source to the device buried in the field. From the utility box, the power cable had to travel underground to a cement curb, go under it, then stay out of sight beneath a dirt track that surrounds the playing field and finally come up in the edge of the field.

Heading for the 50-Yard Line

It was easy to hide a cable under the stadium and in a trench under the grass, but crossing the dirt track was tricky, because digging would leave visible marks. Fortunately, Harvard had recently buried an irrigation pipe under the track, so the power cable was run next to that pipe, and there were no obvious new marks in the dirt. DKE had planned to put the device under the turf just outside the playing field at the 50-yard line, but time ran out and they settled for the 46-yard line.

Following the three scouting trips, eight working trips were required to bury the cable. Each trip involved six to ten people and a multitude of digging tools. Two lookouts were posted in the tower at the base of the east leg of the stadium to watch Soldiers Field Road and the parking lot. If they saw a Harvard Police car or a pedestrian approaching, they signaled with flashlights to a lookout with the digging crew, which then retreated into the shadows until an "all-clear" signal came.

With three people assigned as lookouts, only half of a six-person team could be digging the cable trench and the hole for the balloon and inflator. That hole had to be exactly three feet, three inches deep. If deeper, the device could not emerge; if too shallow, Harvard would notice a bump in the field.

The first step was to cut out an eight-inch-square plug of sod that would



cover the device once buried. The sod was sealed in a plastic bag so it would not dry out and carefully stored so it would not break. Next came removing three feet of dirt. The dirt was extracted using a post-hole digger and trowels and piled on a tarp for disposal.

DKE ended up digging the hole four times. Each night of the last four working trips the teams expected to finish burying the cable, so the main hole was dug. But on the first three tries, the cable-layers fell behind schedule, so the hole had to be refilled. Only in the small hours of Wednesday morning, three days before the game, the hole was dug for the last time.

The ambitious digging effort required a large collection of tools. Climbing over the stadium fence with a shovel was at best difficult, and anyone who chanced to observe the climber must surely be suspicious. To avoid this risk, the DKE teams decided to hide their tools under the stadium. Fortunately, construction was still in progress at the stadium to repair damage from a fire, so the extra tools were not noticed.

To reduce the chances of being seen, work was done only between 2 and 5 a.m. Everyone wore dark clothing and black face paint, and all movement on the field was done by crawling. By the time the digging was finished, every member of DKE had spent a night at the Harvard stadium. The image of mud-covered figures crawling across the dewy grass on cold November mornings is convincing evidence of DKE's determination to succeed.

Turning on the Juice

The utility box that provided power was one that normally controlled the stadium sprinkler system. Since the sprinklers were not used during November, DKE correctly assumed that Harvard was unlikely to notice minor modifications. The box included an ordinary unswitched electrical outlet, and the teams chose a simple method to apply power to their cable. At the end of their cable they installed an ordinary two-prong outlet, which they mounted on a wall near the utility box. Then they made up a power cord with male plugs on both ends. To apply power to the DKE cable at the critical moment, only one quick step was required: plug one end of the cord into the live outlet and the other end into the new outlet.

Every time the trench-diggers started afresh, the power line had to be spliced and soldered with a battery-powered soldering iron. So when the digging was finally finished on Wednesday, the power cable had nine separate splices in it. DKE knew that any of those might fail after the line was buried, but that was a risk they had to take. After one final check, they packed up their tools and climbed back over the fence—not to return until Saturday at game time.

Fully two-thirds of the members of DKE attended the game, most of them wearing fraternity T-shirts. After all, nobody suspected DKE at the time. Getting enough tickets for the game was a slight problem, but scalper prices seemed well worth the cost to savor their triumph.

The DKE strategy was to trigger the device after Harvard's second touchdown. (DKE apparently didn't realize that Harvard rarely scores twice against Yale, but in 1982 that was no problem: Harvard scored 45 points to Yale's 7.) Harvard scored its second touchdown with seven minutes and forty-five seconds left in the second quarter, and two DKE members ducked under the stadium and the rest—as the saying goes—is history.

The device erupted as the two teams were lined up for the third kick-off of the game. The fan assembly rose out of

PHOTO: TIM PLASS/THE HARVARD CRIMSON



the ground, pushing the soil plug off to one side, and 40,000 startled spectators watched as the balloon inflated. Too startled to move, the audience watched the balloon grow slowly. As the letters "MIT" became visible, every spectator knew Harvard had been hacked. The balloon should have grown to be twelve feet across, but Harvard football players started throwing pebbles at it, and one presumably hit its mark when the balloon was about the size of a medicine ball. The balloon had been packed in baby powder to prevent sticking, so its burst produced a cloud of white smoke.

M.I.T. Grabbed the Headlines

Television, radio, and newspaper reporters covering the game were captivated. Michael Madden of the *Boston Globe* called it "the prank of all pranks. . . . If you want to know the truth, M.I.T. won the game." "One of the greatest college pranks in history," said Bob Lobell of Boston's Channel 4. Even President Derek Bok of Harvard was impressed. "They have an awful lot of clever people down there at M.I.T.," he said.

At first DKE savored its glory privately while speculation ran rampant. But by Monday the fraternity gave in and held a press conference at which Bruce Sohn, '83, president of the house, and his smiling partners took credit for their deed by explaining how it was done. "We never came near to getting caught," he said. "It went exactly as we planned."

In addition to creating a media event, DKE had created a substantial hole in the football field. The fraternity had left a note with the device explaining that it contained no dangerous explosive and describing how to put it back into the ground, but the stadium grounds crew didn't find it. Instead they pulled the fan assembly and some of the wiring out of the ground and went to look for dirt to fill the hole. Failing to find any loose dirt, they ended up re-discovering the method DKE had used. The plug of soil covering the device was eight inches across, but the hole underneath was only six inches across, spanned by an eight-inch metal plate. So the Harvard crew put the plate and the sod over the hole, and the game went on. The game was held up for at most ten minutes.

After the game the grounds crew dug up the rest of the device, including the power cable, and the whole thing was turned over to Harvard's campus police.

Posing after a long night's work, a DKE work team could hardly have foreseen the success they were about to achieve.

Official channels were unable to arrange for the device's return. There was even a letter from M.I.T.'s President Paul Gray to Harvard's President Derek Bok in which Gray promised to "enshrine this symbolic highlight of the 1982 football season."

But in the spring of 1983 an unofficial initiative between the campus police departments of the two schools was successful in working out a deal. There was even a small ceremony in which Harvard's Chief Saul Chafin presented the device to M.I.T.'s Chief James Olivieri. Still covered with dirt and sticky with the grease used to prevent corrosion in the ground, the treasure was wrapped in a trash bag and delivered to Chief Olivieri's office. Soon thereafter Olivieri told DKE the good news, and it was arranged for the hack to be recreated for Alumni Day in June (1983). DKE repeated the burial effort—this time on Briggs Field and without the need for secrecy—and more than 1,000 alumni cheered as the inflator's solid engineering gave another perfect performance. □

PHOTO: ROBERT BROOKS

Harvard and M.I.T. Train the *Compleat* Medical Researcher

by Michael Unger

The young man looked for the all the world like a medical student. On the eighth-floor ward at Mt. Auburn Hospital in Cambridge, in a regulation white coat, stethoscope tucked jauntily into one pocket, he was staring through an opthalmoscope at Salvatore DeMarco's retinas.

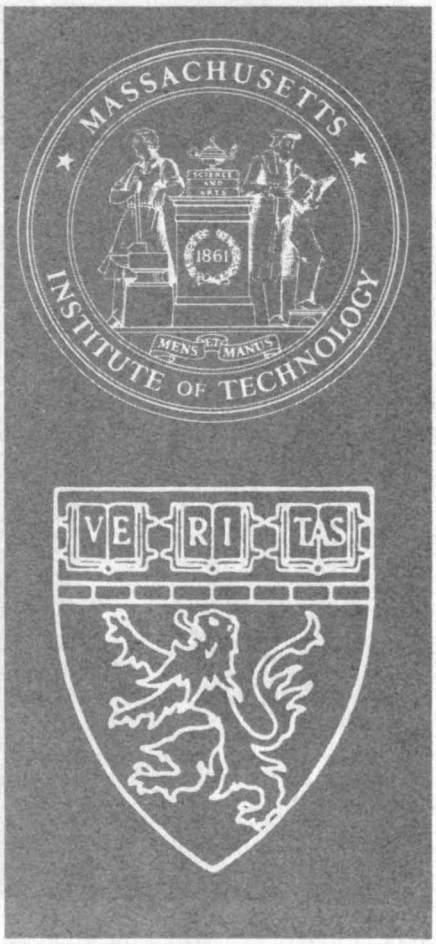
In another ward, he and other similarly medical-looking young men gathered around the bedside of Madelyn Fox, an 85-year-old West Newton woman, to ask every conceivable question about the sharp pains in her right arm.

To the patients, the young men might as well have been medical students—they checked for all the right symptoms, had all the right concerns. But these apprentice medical detectives were graduate engineering students at M.I.T.

The distinction is largely academic. "Those engineering students," says Dr. Charles Hatem, Mt. Auburn Hospital's associate chief of medicine, "*are* medical students." As part of the program in Medical Engineering and Medical Physics (MEMP) offered by the Harvard-M.I.T. Division of Health Sciences and Technology (HST), they take classes at the Harvard Medical School and go through a 12-week clinical "clerkship"—making diagnoses and participating in patient care under the supervision of senior medical practitioners.

HST was established in 1971 to create a new breed of researcher—one trained first at Harvard as a physician or at M.I.T. as an engineer or scientist. But each graduate has a broad grasp of both the complexities of modern medical technologies and the special needs of patients and health care practitioners in hospitals and other clinical settings.

It sounds logical enough now. But at the time the program was launched, the idea of incorporating physics, mathematical modeling, engineering, and computer science into clinical practice was foreign to most physicians. Equally strange to scientists and engineers was the notion that "hands-on" experience alongside doctors, nurses, therapists, and medical technicians serving patients could help students do better biomedical research and produce more appropriate medical instruments and procedures based on rapidly advancing new technologies.



HST has lowered those mental barriers. The four students at Mount Auburn Hospital, for example, were learning how Madelyn Fox came to require an artificial shoulder as a result of progressive osteo-arthritis. They were also studying whether Salvatore DeMarco's dizziness and slurred speech could be related to cardiovascular problems. But their real goal in the clinic was different—to try to reduce the incidence of medical equipment that is too awkward to use, is needlessly uncomfortable for the patient, or breaks down under the strain of normal clinical use.

As they made their rounds, Scott Greenwald, S.M.'86, who is studying the design of electrical instrumentation for detecting diseases of the heart and blood system, was observing his classmate Charles Stearns check Salvatore DeMarco's retinas. Greenwald could see how important it was that the opthalmoscope not have any projections that poke into the patient's face. He also noted that DeMarco was wearing an uncomfortable-looking heart monitor to detect irregular heart beats.

"I want to understand how a physician uses new medical devices in the hospital," Greenwald said "—how to make instruments that work better, how important it is to provide more memory and greater facility in transmitting data.

"I want to learn to think the way a physician thinks . . . so as a physician-engineer working with the doctors and their patients, I can design something better."

HST enrolls about 40 new graduate students every year—30 from the Harvard Medical School who are pursuing M.D. degrees and 10 from M.I.T. who are studying for Ph.D.s in physics or engineering specialties related to medical research. A number of the M.D. students also pursue a Ph.D., and many of the MEMP students go on to earn the M.D. as well. In the very near future, students from M.I.T.'s Department of Applied Biological Sciences will be able to enroll at HST to work toward degrees in areas such as quantitative pharmacology, drug delivery systems, and biotechnology techniques. In addition to classes in science, engineering, and medicine, HST students make wide use of the clinical and medical research situations offered by the concentrated Boston-Cambridge medical community.

Many of these students create programs in areas where few specialists al-

MICHAEL UNGER, a former Bush Fellow, is a journalist on the staff of Newsday *on Long Island, N.Y.*

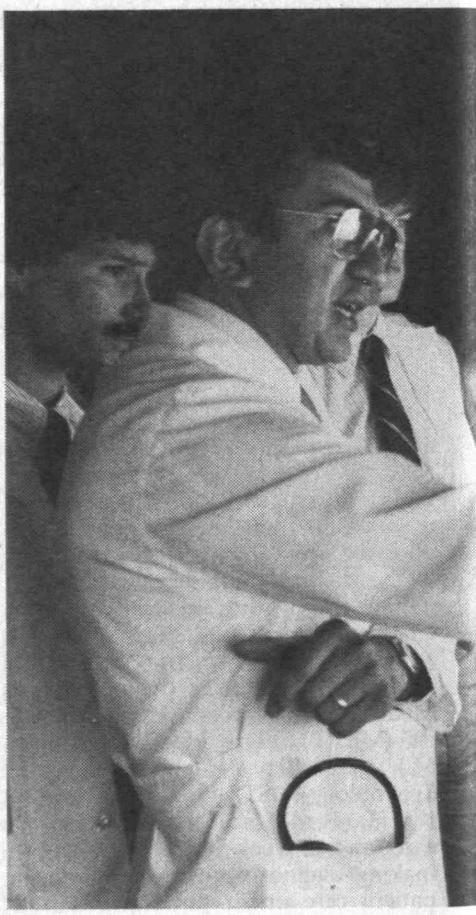
It's hard to separate the players without a scorecard, but the winners will be the patients

ready exist, but all their work has a common thread: the HST imperative to bridge the gap between the patient-care setting and the medical laboratory.

HST is the latest example of a long history of collaboration between M.I.T. and Harvard in medicine, health, and engineering that dates back to the founding in 1912 of the first school of public health in the country. Called the Harvard-M.I.T. School for Health Officers, it specialized in preventive medicine and sanitary engineering. In 1922 it became the Harvard School of Public Health, but even therefter the two universities continued their pooled efforts in this field.

In the 1960s, when M.I.T. decided not to start its own medical school despite assurances of federal support, the presidents of Harvard and M.I.T. established a Joint Committee on Engineering and Living Systems to explore opportunities for joint research and training in biomedicine and life sciences. That committee conceived of HST, which was subsequently established under the direction of Irving M. London, a Harvard Medical School graduate with wide experience in fostering education across many fields of medicine, bioscience, and engineering. The M.D. program was initiated in 1970, followed by the MEMP program in 1978.



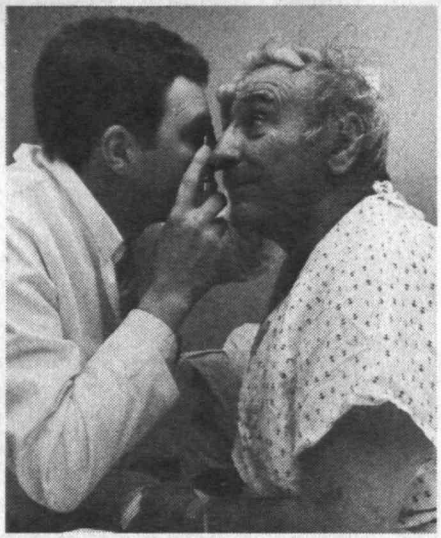


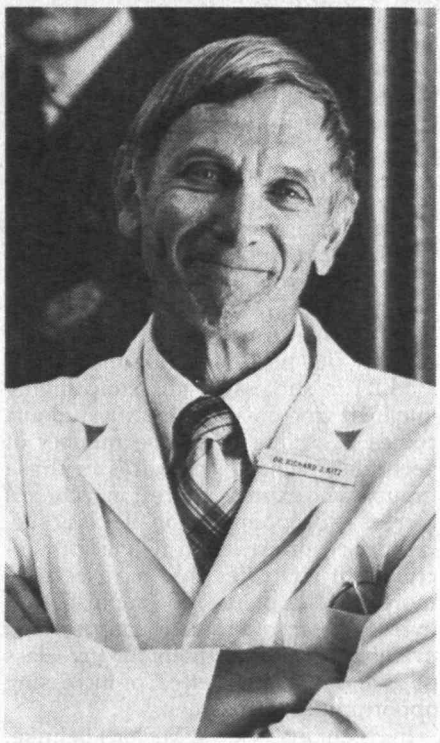
HST is now under the leadership of two co-directors—Dr. Roger Mark, '60, Matsushita Associate Professor of Electrical Engineering in Medicine who holds an electrical engineering Ph.D. (1966) from M.I.T. and a Harvard M.D. (1965), and Dr. Richard J. Kitz, a senior member of the faculty of the Harvard Medical School who helped to establish the Biomedical Engineering Department at the Massachusetts General Hospital (MGH).

Boston-Cambridge area hospitals, including MGH, play a key role in HST research and teaching programs. The faculty in the HST division hold major appointments in the Harvard Medical School or an M.I.T. department, and many have ties to one or more of the area research hospitals. Their links form pathways for the students to move freely through Boston's large, interdisciplinary biomedical research and training establishment.

Representative of the multi-disciplinary investigations carried out by HST faculty in collaboration with area hospitals is the research led by Ernest G. Cravalho, associate director of HST. Dr. Cravalho heads the MGH Department of Biomedical Engineering and is also the first Edward Hood Taplin Professor of Medical Engineering at M.I.T. His projects span a range of medical applications of extreme cold—the freezing and thawing of blood, the preservation at very low temperature of biological materials such as livestock embryos, and the first fully programmable cryomicroscope, a device to display microscopic images of materials at very low temperatures, where molecular motions are reduced. Dr. Cravalho has also applied his knowledge of fluid dynamics to the design of instruments for studying lower urinary tract problems of the elderly and those with spinal cord injuries.

The four HST medical engineers working at Mount Auburn illustrate the range of interests HST students pursue. Stearns, with a B.S. from Case Western Reserve in biomedical engineering, is working in the MGH physics lab learning to monitor blood flow in the heads of stroke patients with a process called Positron Emission Tomography (PET-scan). Greenwald, whose master's is in electrical engineering, is designing spe-







Dr. Roger Mark, '60 (far left) and Dr. Richard Kitz (immediate left, below) are the co-directors of HST. Dr. Charles Hatem (center) of Mt. Auburn Hospital, Cambridge, has the attention of engineering students (left to right) Jeffrey Lotz, Robert Cothren, '81, and Scott Greenwald, S.M. '86, as he points out details on an x-ray. (Left, top) Charles Stearns, S.M. '86, examines the eyes of Salvatore DeMarco.

cial instruments to monitor the heart's electrical activity.

Jeffrey Lotz, who finished a master's degree in mechanical engineering at Stanford before entering HST, is working on the design of non-invasive ways to predict hip fractures at Boston's Beth Israel Hospital. Robert Cothren, '81, who continued at M.I.T. for a master's degree in chemical engineering, is now working at the Cleveland Clinic and M.I.T. on state-of-the-art use of lasers to clear arteries of cholesterol and other blockages.

Many HST alumni are bringing distinction to the program by leading their research fields. As an HST student Dr. Dennis Orgill, Ph.D.'83, worked on artificial skin with M.I.T. Professor Ioannis V. Yannas, S.M.'59, and Dr. John Burke at MGH. Dr. Orgill is now a surgical resident at the Brigham and Women's Hospital in Boston, working on nerve regeneration in animals. He said his HST work to develop a more advanced version of the artificial skin exposed him to "a multidisciplinary framework" that demonstrated the value of interaction among investigators from different disciplines. "No one person can solve some of these complex problems on his or her own, and the HST program facilitates interaction."

One of the first HST graduates was Dr. Richard J. Cohen, Ph.D.'76, who now heads HST work in biomedical engineering. Cohen is a prominent contributor in a number of medical instrumentation fields, including electrophysiology of the heart and optical techniques that eliminate the need for radioisotopes in immunoassays. Cohen's experience was typical: after graduating in physics from Harvard in 1971, he looked around for a graduate program that would enable him to apply physics, chemistry, and mathematics to problems in biology and medicine.

"I naively assumed there were many people and departments engaged in that kind of activity—it just seemed like such a logical thing to do," Dr. Cohen recalled. Not so; he found only one functioning program, at the University of Rochester, that met his criteria. But HST was being organized at the time. "I was particularly interested because M.I.T.'s physical sciences and engineering strength would be brought to bear. I found somebody with exactly the same outlook that I had (M.I.T. physics professor George B. Benedek), and I was the first student enrolled in the combined HST Ph.D.-M.D. program."

A Schizophrenic Existence

Cohen remembers that he purposely set up for himself a "schizophrenic existence, where I was taking physics courses concurrently with medical courses. I did three months of clinical rotations and then would go back to the lab. I was getting a Ph.D. in a field that was historically so separate from medicine that I felt there was a great advantage in moving back and forth between the two cultures—in being able to look at problems in medicine from the point of view of the physicist."

And that, says Roger Mark, is precisely what HST is about. "The objective is to solve real-world problems," he says. "To completely understand some of these issues, you must draw upon disciplines beyond your own. If you're an engineer, you have to understand the importance of biochemistry, genetics, immunology, and so on. And if you're a biologist or chemist, you have to recognize the value of mathematical modeling and engineering concepts. That's the objective." □

PHOTOS: FRANK REVI, '86; MARGO WOODRUFF

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Class of '90: How Was It Chosen?

Thirty-eight percent of the 1986 freshman class is women. That is a remarkable increase from the 28 percent women in the 1985 freshman class. It means that for the first time in Institute history, men outnumber women in their class by less than two to one.

In a freshman class of 991, there are 378 women and 104 minority students (Native American, Mexican-American, Puerto Rican, or Black). They are drawn from a total pool of 6,210 applicants, of whom greater numbers than ever were women or minority students: 1,366 women, 360 non-Asian minorities.

M.I.T.'s success in attracting highly qualified women and minority students comes at a time when the number of secondary school graduates in these groups who express interest in technical careers is dropping nationally. It is success based primarily on two factors: recruitment strategies that have become more diverse, intense, and sophisticated in recent years; and small changes in the evaluation of applications for the Class of 1990 that had the effect of increasing opportunities for women.

In recent interviews, Michael Behnke, the director of admissions, and Bette Johnson, associate director of admissions for research and information services, discussed the admissions process and the ways it was studied and altered to select the present freshman class.

Since the early 1950s, Behnke said, admission to M.I.T. has been based on a ranking of applicants on numerical personal rating (PR) and scholastic index (SI) scores.

The PR reflects everything students did outside the classroom and the intensity and creativity with which they did it. Clubs, hobbies, jobs, volunteer work—all were fodder for the PR.

A Unique Equation

The SI is a measure of academic strength arrived at by applying a regression equation unlike anything Behnke is aware of at any other institution. Elements such as the verbal and math SAT scores, achievement test scores, rank in high school class, and percentage of that class going to college were assigned relative weights. The formula applied to those elements produced a number from one to 99 that indicated the probability that an applicant would earn an average of "C" or better in his or her freshman year.

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Anyone who wanted to really see the balance of men and women in the Class of '90 had only to take a look at the Freshman Picnic.



plicant pool was traditionally divided among the cells of a matrix. Along one axis of the matrix were ten subdivisions for the SI scores (one to 10, 11 to 20, and so on) and along the other were six subdivisions for PR ratings—60 cells in all. All the applicants in one cell were evaluated together, and each cell had a ranking. Virtually all of the students with SIs of 90-99 and PRs of 10 (highest possible) would be admitted; smaller and smaller segments of each cell with lower scores were successful.

On that system, a statistically insignificant difference in test scores could bump an applicant to a lower cell and reduce the chances of admission. Since women, on average, have slightly lower test scores than those of the men, the system worked against them.

The old system had other disadvantages. Since the personal rating was supposed to be based on non-academic activities, it gave little opportunity for evaluators of applications to comment on those academic qualities that are not measured on standardized tests—motivation and creativity, for example. There was no way of discriminating between regular and advanced placement courses on applicants' transcripts. And many schools had dropped class rank, which lowered scores for students who then lacked this datum.

Clearly, concluded Behnke and his colleagues, the time for change had come, and there will be substantial changes in the admissions procedures for the class that enters in 1987. (More about that in the January *Technology Review*.) But there were things that could be done in the short term.

First of all, the 1985-86 applicants were divided into only three large groups according to SI scores, instead of ten. Small differences in scores thus had much less impact on the chances for admission, which made the system less discriminatory against women.

Lower SI Made No Difference

At the same time, Johnson, who holds a doctorate in educational testing, did a study of the relationship between the SI and various indices of a student's performance at M.I.T. She found that though women enter with lower average SI scores than those of the men, the women graduate in the same proportion and with grades comparable to men majoring in the same courses.

Why does this happen? Johnson suspects that women whose performance is less impressive on the standardized tests and high school grades that go into the SI have not been pushed to excel in math and science. High school girls are expected to be attractive and popular and to do well in English, Johnson believes, but when they get to M.I.T. "the rules change." Suddenly they are in an environment where *everyone* is expected to do well in math and science. "The women do work very hard and they meet the standard," Johnson found.

The lesson from all this: M.I.T. could admit women with slightly lower SIs than men and retain undiminished the very high standard of its graduates.

The Institute is not alone in this finding, Behnke notes. The College Entrance Examination Board, sponsors of the SAT, has also found that its tests underpredict the performance of women relative to men, and the board urges colleges to take that into account in using the tests for admissions decisions.

There is another noteworthy feature of women students: they consistently distribute themselves differently around the Institute, Johnson said. A smaller proportion of the women students major in engineering. "Admitting women is not only good for the women," Johnson says, "it is good for M.I.T.," since it is vital to have strong enrollments in all academic programs.

Johnson did note that no conclusions could be drawn from her study about the validity of the SI as a predictor of performance for minority students, because their numbers were too small to be statistically significant.

All this relates to the selection process as applied to the applicant pool. But 1985-86 also saw a continuation of the measures to attract more women and minority students to apply to M.I.T.: the visits of AMITA members to Boston and Los Angeles area high schools to encourage girls to study math and science to keep their academic options open; special mailings to women and minority students with high SAT scores; phone calls by women students to females who had requested information about M.I.T., urging them to apply; and a special weekend on campus for women who were offered admission, to encourage them to accept that offer. These measures seemed to make a difference. Minority enrollment was further boosted by summer programs for academic upgrading, help finding summer jobs, and long-term career planning. □

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Alumni Endow Professorships in Health Sciences

John F. Taplin, '35, and his family gave a professorship to M.I.T. early this year because they understand the need for "a new kind of health professional—a medical engineer or physicist whose knowledge and skills will be used in a clinical setting as a peer of the physicians."

At nearly the same time, Karl R. Van Tassel, '25, was giving funds for a career development professorship because of his concern "to advance the cutting edge of . . . cell biology for clinical benefit."

Indeed, the promise of new technology applied to health care has motivated at least four alumni to make major gifts to M.I.T. in 1986. In addition to the support from Taplin and Van Tassel, there have been a career development professorship from Allen Latham, Jr.'30, and his wife, Ruth Nichols Latham; and a professorship fund in the life sciences from Robert A. Swanson, '69.

Three of the four donors have been associated for many years with work at the interface of technology and the health sciences. Swanson is a cofounder and chief executive officer of Genentech, Inc., San Francisco, one of the nation's leading biotechnology firms. Latham is founder and chairman of Haemonetics Corp., Braintree, Mass., a major source of machines for processing blood platelets needed by patients in intensive cancer chemotherapy. And Taplin is an entrepreneur and inventor who has founded and directed five companies that make and market medical and process instruments and controls.

Only Van Tassel came to his interest in biotechnology after a technical career in an unrelated field: electrical engineering and its management. After working at General Electric and serving as general manager of the Knolls Atomic Power Laboratory, Van Tassel joined A. B. Dick Co., Chicago, in 1956 and soon became its president.


E. Cravalho


M. Kreiger

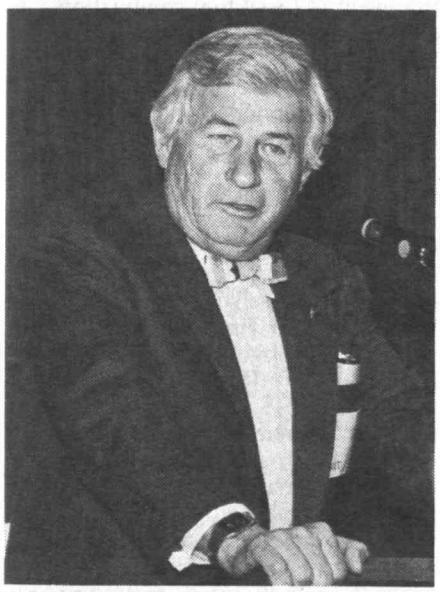

R. Lee


D. Raulet

All four donors share the gratitude to M.I.T. that Van Tassel expressed at the time of his gift: "It is fulfilling to return to the Institute some small measure of what this font contributed to the product of my life," he said.

The endowed chairs they made possible are being filled by professors with extraordinary qualifications:

☐ Ernest G. Cravalho, Edward Hood Taplin Professor of Medical Engineering, is a mechanical engineer widely known for the application of extremely low temperatures to biology and medicine—notably to freezing and preserving blood cells. As Taplin Professor, he has moved his office to Massachusetts General Hospital (MGH) in Boston, where he's now chief of biomedical engineering and the first effective operational link between a major teaching hospital and the Harvard-M.I.T. Division of Health Sciences and Technology (see page MIT 5). Cravalho has worked with the latter since 1977 as associate director of its programs in Medical Engineering and Medical Physics. As Taplin Professor, he's now a member of



P. Cooke

MGH's General Executive Committee, the hospital's highest medical board.

☐ Monty Kreiger, the first Latham Family Career Development Associate Professor, is working on a basic medical problem that relates to the transport of cholesterol in the blood stream. In particular, he is studying the way cells internalize physiologically active macromolecules from extracellular fluid.

☐ Raphael C. Lee, Sc.D.'80, the first member of the faculty to hold the Van Tassel Career Development Chair, has a unique background in electrical engineering and reconstructive surgery. The focus of Lee's interest is on the impact of electrical and mechanical stresses on the performance and development of skeletal and connective tissues, and the cellular mechanisms involved. His clinical practice is in treating hand injuries, electrical burns, and birth defects. Lee was an 1981 winner of a MacArthur Foundation grant.

☐ The Robert A. Swanson Assistant Professorship in the Life Sciences has been awarded to David H. Raulet, Ph.D.'81, who is credited by Provost John M. Deutch, '61, with "outstanding work in immunology."

Responding to Swanson's gift, David S. Saxon, '41, said that the donor would "find great satisfaction in seeing a succession of talented and able people serve the Institute and the biological sciences." That expectation must be in the minds of all four donors in strengthening work that holds the special appeal of humane service to so many.

Indeed, Taplin is no stranger to this experience: he and his family recently founded, and he serves as president of, the National Health Research Foundation, and he's a new trustee of the Boston Biomedical Research Institute. Mr. and Mrs. Latham have been generous supporters of M.I.T. work in molecular biology and the health sciences as members of the Sustaining Fellows Program, and all their children—three sons and one daughter—hold M.I.T. degrees. Swanson, too, has made earlier gifts to M.I.T.—a graduate fellowship in molecular biology and an undergraduate scholarship fund. ☐

Cook Named Alumnus of Year

Pushing new science into new products into new markets, doing things that have never been done before—that's what excites Paul M. Cook, '47, founder, chairman, and chief executive officer of Raychem Corp. in Menlo Park, Calif. He began Raychem in 1957 with $50,000 and five products (three of which survived), and under his leadership it has grown to a $750-million worldwide company which has developed thousands of products based on a single pioneering technology, radiation chemistry.

"Paul Cook is a visionary with a commitment to his visions," said Charles McLaughlin, S.M.'68, when Cook was honored as "Alumnus of the Year" last March for 1986 by the M.I.T. Club of Northern California. "He deserves all the credit we're here to give him," McLaughlin added.

Raychem employs approximately 9,500 people in 50 countries, of whom one in nine works in research and development. Raychem is a supplier of finished products in fundamental materials areas including heat-shrinkable metals, ceramics, and conductive polymers. ☐

Seminar Success in Boston, Washington

"Illuminating the Dark Continent: Africa Today and Tomorrow" is the topic for six dinner seminars arranged for the 1986-87 Boston Seminar Series. Last year the same series was on basic resources—"Alchemy for the 21st Century: Water, Air, Earth, and Fire."

In Washington, last year's topic for a similar series of six seminars was "Biotechnology: Issues and Applications." The year before: eight meetings on "Commercialization of Space: Profits and Prophets." This year the Washington Seminar series looks at the future of biotechnology and its potential in medicine, agriculture, and industry.

In the decade since the Boston Seminar began, the idea of a continuing series of dinner/seminar meetings for alumni has found fertile ground in only two settings—the M.I.T. Faculty Club, which hosts the Boston group, and the Mary Graydon Center at the American University, where seminars organized under the M.I.T. Club of Washington have met since 1982. But in both these communities the seminar concept is deeply rooted, well nourished, and thriving.

The idea is generally credited to Max Seltzer, '18, who convened the first planning group in 1974. His reasoning: the Cambridge community is rich in intellectual resources on countless vital issues, and most alumni have too little opportunity to tap that richness. Hence the usefulness of a series of thoughtful presentations—especially if given in a social setting that appeals to alumni *and* their spouses.

In Washington, Viguen R. Ter-Min-

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assian, '64, and Kenneth F. Gordon, S.M.'60, took up the idea, organizing an initial six-seminar series on "Science and Technology: Has the U.S. Lost the Initiative?" which attracted just under 100 registrants. The registration for last year's biotechnology series was nearly 150, about half of them non-alumni, and some 40 applicants were turned away for lack of space. The fee for six meetings, including dinners, is about $100 in both cases.

Registration is still open for the 1986-87 Boston series. Its goal, in the words of chairman Claude W. Brenner, '47, will be "to remove the veil of mystery" that obscures Africa for most westerners. The sessions will be devoted to prospects for economic, social, political, and technological development.

Water, Air, Earth, and Fire

For a sampling, consider the 1985-86 Boston Seminar Series, of which Brenner was also chairman. Indeed, the title of the series and of the individual presentations reflected Brenner's erudition, and his introductions of the speakers were an attraction in their own right.

☐ "The Ancient Mariner Rephrased: Water, Water Everywhere—What Will We Have to Drink?" by Peter P. Rogers, Professor of Environmental Engineering at Harvard: The earth is a very wet place. Our water problem is not shortage but maldistribution, and it has its ultimate roots in economics: consumers may pay more for water today in Philadelphia, where it is plentiful, then in Tucson, where resources are nearly exhausted.

☐ "T.S. Eliot Remembered: 'Clean the Air! Clean the Sky! Wash the Wind!'—Who? How?" by Anthony D. Cortese, director of the Center for Environmental Management, Tufts: Major successes have been achieved in controlling air pollution since the 1960s, and there are grounds for optimism that this resource will not further deteriorate in the U.S. There remain only the issues of increasing atmospheric sulfur and carbon dioxide, the sources of acid rain and the "greenhouse effect," both of which are the result of fossil fuel combustion.

☐ "Malthus Revisited: Can the World Feed Its People?" by Jean Mayer, president of Tufts: The food situation in the world is better today than ever before everywhere except in Africa. If the Malthus scenario prevails in Africa, it will be because of social and political mismanagement. The systems in place fail to encourage farmers to grow food for market, pressuring them instead to hoard for themselves.

☐ "Chariots of Fire Redesigned: What Will Fuel the Engines of Commerce and Industry?" by John M. Deutch, '61, provost of M.I.T.: Does our society have enough understanding and discipline to manage the inevitable transition from fossil to alternative fuel? The most important steps now would be to gradually wean us from our mindless dependence on gas and oil by engineering a gradual increase in their price, mounting sustained research and development on alternative energy sources, and increasing incentives for energy economy. But we do none of these.

☐ "Exodus Revised: Where Will My People Go?" by Lester C. Thurow, Billard Professor of Management, M.I.T.: The global population problem is a problem of managing lifestyles. For example, the "carrying capacity" of the earth would be amplified if many countries adopted Japanese strategies for living in densely populated areas. It would shrink if the American lifestyle prevailed. The real difficulty is that population changes happen faster than lifestyles and behavior can be modified to accommodate the increased numbers.

☐ "Lincoln Steffens Recalled: 'I Have Been Over into the Future and It Works' " by Solomon J. Buchsbaum, Ph.D.'57, executive vice-president of AT&T Bell Laboratories: There are no problems facing the world that cannot be solved; the human race can prevail. We have most of the information we need and the technology to disseminate it; and in nuclear fission and fusion we have the energy resources we ultimately must use. All we lack are the collective will and the global infrastructure. ☐

12

We have heard from Lillian Noyes that her father, **Jonathan A. Noyes,** died peacefully July 22, 1986, at the age of 96. She reported that at a memorial service "the recollections were of a warm and generous heart, and a spirit full of courage, fun, and the joy of living."

Mr. Noyes was born in Waltham, Mass., and was a long-time resident of Dallas and Bryan, Tex. He worked for 47 years at the Joy Manufacturing Co., a mining and oil machinery manufacturer. He was active in sales and engineering, and was involved in mining, oil, and construction. Mr. Noyes was a member of the Unitarian Church, a life member of AIME, and a life member and fellow of ASME, in addition to being active in many civic and professional organizations. He is survived by two sons, three daughters, 11 grandchildren, and ten great-grandchildren.—*ed.*

16

We are happy to report 93rd birthday celebrations for **Dina Coleman** and **John Fairfield**. These excerpts from the *Lexington Herald-Leader* of Lexington, Ky., give us a nice account of Dina's celebration: "No one seems to know when Coleman gained the title 'Count,' but some of his friends say it was because he always wore pince-nez glasses on a black ribbon.

"Other friends say you could always tell when the seasons changed because the Count switched from his felt hat to a straw sailor for his walks from his office on Short Street to his favorite place for lunch and a hand or two of cards—the Lexington Club."

John Fairfield recently wrote: "Sorry that I missed the '16 reunion. My health is okay (on age 93 scale, giving credit to M.D.). Gardening continues, scale reduced. Birthday party for me not on scale of **Paul Duff** and **Dina Coleman.** Son, daughter, younger grandson, and their spouses, older grandson, and nephew here from West Virginia and Baltimore, and points closer. Fine time."

Dan Comiskey notified us of his wife's passing in this note. "The August/September 1986 *Review* arrived today with me alone since August 2 when dear Grace went to her well-deserved reward in full peace and at home, where she loved to be. We were 63 years together. I had two lovely letters from Frances Duff. Frances praised Grace as one whom she admired greatly." Dan, we all loved Grace for her indomitable spirit and ever-present smile. She enriched our lives.—**Bob O'Brien,** Acting Secretary, 28 Marinel Ave., No. Chelmsford, MA 01863

17

John M. DeBell of Enfield, Conn., a pioneer in the plastics industry who co-founded DeBell and Richardson, Inc., died July 9, 1986. While working for General Electric Co., he developed phenolic resins and molding compounds and was involved in introducing plastics to this country. DeBell became research and development director for the Fiberloid Corp., now part of Monsanto Co., during the commercialization of safety-glass interlayer sheeting. He also co-authored *Germany Plastics Practice,* a book which became a standard reference on plastics. He held many patents in the field of plastics and was inducted into the Plastics Hall of Fame in 1976.

DeBell was an army veteran of World War I, serving as a lieutenant in the l6th Field Artillery, where he saw action at Chateau Thierry, St. Michel, and the Argonne. In addition to membership in social and professional organizations, DeBell was trustee of Johnson Memorial Hospital and director of Enfield Social Services, Inc. In l968, he was named Enfield's "Man of the Year." He was also a choral singer and had performed with the Handel and Hayden Society in Boston. For many years he was the solo tenor at Trinity Church in Lenox, Mass.—*ed.* (**Walter J. Beadle** , Secretary, Kendal at Longwood, Box 217, Kennett Square, PA 19348)

18

We enjoyed a most pleasant interlude these quiet summer months with a visit from Lorraine and **Stuart Caldwell**, 1918 neighbors now living in Rockport. We gave them a glimpse of life at North Hill—the swimming pool; the workshops for pottery, weaving, painting, carpentry; and the exercise room. They got an idea of other activities—lectures, musical programs, and trips to museums, Symphony Hall, just to mention a few. We had a chance to look back at the years since those days at M.I.T.

Through the courtesy of his daughter, Mary Helen Haecker, we note with sadness at this late date the death of **Stephen Hoye** in 1984.

The Hackensack *Record* notes the passing of **Edward N. Little** with the following summary of his career. Edward Little, 92, of Englewood died April 27, 1986. Before retiring in 1958, he was an electrical engineer for AT&T in New York. He was graduated from Yale University and the Massachusetts Institute of Technology. He was a member of the Appalachian Mountain Club and was chairman of the Sierra Club, North East chapter. He also was active in the Boy Scouts of America. The Little Chism Trail on the Palisades in Tenafly is named for him and Murray Chism, who hiked the Appalachian Trail in eight months in 1959. He was an Army Air Corps veteran of World War I. Surviving are his wife, Alice Demarest Little; three daughters, eight grandchildren, and eight great-grandchildren.—**Max Seltzer,** Secretary, 865 Central Ave., Needham, MA 02192; **Leonard L. Levine,** Assistant Secretary, 519 Washington St., Brookline, MA 02146

19

We regret to report the deaths of two more of our classmates. **Milton A. Loucks** died on June 4, 1986. His home was in Snyder, N.Y. He is survived by his son, Charles E. Loucks, of the class of 1944. Also **Louis J. Grayson** died on April 30, 1986. His home was in Bethesda, Md., and he is survived by his widow Aline who we had the pleasure to meet at the last reunion that our class held at the Chatham Bars Inn. Both of these classmates attended our reunions and we remember them with pleasure. These deaths reduce our class living members to 57.

We were pleased to receive a letter from Edith H. Neal who is the daughter of our late classmate **Daniel C. Hall**. She writes that her mother Mrs. Daniel Hall read the *Technology Review* regularly to keep posted on some of our classmates that she knew up until her recent death.

Now hoping you have much to be thankful for this Thanksgiving day we wish you the best.—**W.O. Langille**, Secretary, Box 144, Gladstone, NJ 07934; (201) 234-06903

20

Word has reached us of the death of **Alfredo de Zoubiria** of Cartageua, Columbia. Zoubay was a handsome, black-haired classmate with flashing black eyes. The impact of his personality made him one to remember.

It would be a pleasure to hear from you. (Please note that I have moved from 702 to 313 which is specially equipped for handicapped persons.)—**Harold Bugbee**, Secretary, 313 Country Club Heights, 3 Rehab Way, Woburn, MA 01801

21

John T. (Slide) Rule, former dean of students and professor of graphics, died on May 24, 1986 in Elkhart, Kan. Your secretary remembers Jack as a fellow resident of the 6th floor of Runkle Hall in our freshman year at M.I.T. Several times a day we climbed up five flights of stairs to reach our dormitory rooms and developed wonderful leg muscles. Jack's roommate was **John W. Barringer**—a fellow resident of St. Louis.

Jack Rule began his career as an industrial engineer at Curtis Aircraft. He taught at the Taylor School for Boys in St. Louis where he headed the Science and Mathematics Departments. In 1936, he returned to M.I.T. and the following year, became head of the graphics section. He worked on 3-D photography with Dr. Edwin Land and created a 3-D movie for the 1941 Worlds Fair. During World War II, Jack was in charge of the development of the Mark I machine gun trainer for the U.S. Navy. He was also associated with the Research Department of the Polaroid Co. He served as dean of students at M.I.T. from 1956 to 1961. Jack was a great guy with lots of fun in his makeup, and one who could be counted on to write me a delightful letter once a year. We shall miss him.

This is a month in which there is practically no news. Your secretary took a six-day bus trip in July to Nova Scotia, which included an overnight ride on a steamer from Portland, Maine, to Yar-

mouth, N.S. The trip was sponsored by the Albany chapter of the Telephone Pioneers of America. Nova Scotia is a green country with no real mountains. Halifax, the capitol, is a clean impressive city. We made a most interesting tour of the Alexander Graham Bell Museum at Baddeck, which showed that he not only developed the telephone but taught the deaf, and pioneered in the development of airplanes and hydro-foils. It was a fine tour.

Now in the middle of August, I am just back from two weeks at Squam Lake, N.H. (*On Golden Pond*) where I swam, hiked, canoed and participated in elbow bending activities. I think I'll stay put for a while. Please write me.—**Sumner Hayward,** Secretary, Wellspring House E64, Wash. Ave. Ext., Albany, NY 11203; **Samuel E. Lunden,** Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

22

Since the class established the 1922 Professorship at our 40th, the chair has been filled by Professors Wulff, Gray, Lamson, Mattuck and Wolff (the current occupant, Cynthia G., professor of literature). The 1922 Career Development Professorship has been filled, starting in 1973, by two professors, five associate professors, two assistant professors and one senior lecturer. The 1922 Career Development Assistant Professorship has at present its first occupant. The class can be proud that the money contributed has been put to such worthwhile ends.

Martha Munzer's article published in the *U.S. Woman Engineer* and referred to in the July notes was about "A Female Student at M.I.T. circa 1920," not "A French Student - - -" as I incorrectly reported. . . . In the August 1986 issue of *Yankee* magazine is a good picture (in color) of the bowling greens "smooth as a billiard table" at **Bunt Spalding**'s Spalding Inn and Club at Whitefield, N.H. The annual Lawn Bowling Tournament was held there in mid-August.

George P. Deane, 86, died February 14, 1986, in Middleboro, Mass., after a brief illness. Before retirement in the mid-sixties, he was for 41 years a chemist and director of Barbour Welting Co. of Brockton. He is survived by a son, George, a sister, three grandchildren and one great-grandson. . . . **Carl Herrick Cummings**, 87, died March 2, 1986, in Torrington, Conn. A longtime resident of Litchfield, Conn., he had been president of Industrial Appliance Co., general manager of Haydon Mfg. Co., vice-president of General Time and director of the Hartford Fire Insurance Co. He was also active in town affairs, being on the board of finance for 12 years and chairman for four. Surviving are his wife, one daughter, two sons, 11 grandchildren and 11 great-grandchildren.

Victor F. Van Neste, 86, of Milton, Mass., died March 22, 1986, after a brief illness. He was the retired sales manager for Eckel Industries, Inc. of Cambridge. Prior to that, he had been the New England sales representative for the National Gypsum Co. of Buffalo. He is survived by three sons, a daughter and seven grandchildren. . . . **Howard B. Upham**, 87, died May 29, 1986, at Cashiers, N.C. No information as to his career has reached me. He is survived by his wife, Edna. . . . **Charles Randolph "Randy" Myer**, 87, died July 22, 1986, at his home in Wilton, N.H. Early in his career he served for many years as plant manager for Whiting Milk Co. of Boston. Subsequently he founded and operated the Souhegan Wood Products of Wilton. Randy was an enthusiastic alumnus, regularly in attendance at reunions and other M.I.T. affairs. He is survived by his wife, Fanny, whom many of us know with affection, a son, John R., a daughter, Elizabeth St. John Dunn, six grandchildren and six great-grandchildren.

Theodore P. Shlikoff, our oldest classmate, died April 10, 1986, at age 98 in Guntersville, Alabama. He was buried in Jackson, N.J., next to his wife who died in 1963. There are no survivors. Shlikoff, a graduate of St. Petersburg Technological School, came to the United States in 1914 to buy war material for the Tsar. He was still here at the start of the Russian Revolution. M.I.T. accepted him on the basis of a Russian professor's recommendation. After graduation he worked for American Can Co. in Cincinnati and Irvington, N.J., as a machine designer, retiring in 1952. Then he worked for a defense contractor in Newark until his second retirement in 1962. A close friend, Mr. Moshkoff, invited him to live with the Moshkoff family in Guntersville, Ala. He was there until 1975 when disability required his going to a nursing home where he remained until his death. A letter from Mr. Moshkoff's son, Gregory, says that the Moshkoffs visited Shlikoff regularly over all those years, that Shlikoff was proud of being an M.I.T. graduate, that his diploma always hung on the wall of his room, that he was a regular contributor to the Alumni Fund and that his mind was clear to the end. Mr. Gregory Moshkoff has kindly offered to supply further details of Sklikoff's life during the past 23 years should any classmate wish it. His address is Gregory S. Moshkoff, Rt. 1, Box 80, Warrenton Shrs., Guntersville, AL 35976.

We extend our condolences to the families of the above deceased classmates.—**Yardley Chittick**, Secretary, Box 390, Ossipee, NH 03864

23

Your secretary/treasurer wishes to apologize to **Wilson Potter** and family for an error in the May/June 1986 notes, giving his obituary. A newspaper clipping giving an obituary of Winthrop F. Potter was received marked "23". Wilson being the only Potter in our GREAT HISTORY was confused with Winthrop who actually is Class of '22.

On the afternoon of August 2nd your secretary/treasurer had the pleasure of a visit from **Al Pyle** and his son-in-law, Richard Kayne, who is a professor of linguistics at the Institute. He is married to Al's daughter, Cynthia.

Joseph Chaffee died on February 25th. He graduated with our class in electrical engineering. He was a member of the technical staff of Bell Telephone Laboratories at Murray Hill, N.J., for more than 40 years. He was elected a fellow of the IEEE for his work in frequency modulation. During World War II he worked on radar equipment and guided missiles. Since the war he was occupied with studies of microwave radio relay systems and the Telstar Project.

Mason Harris died on March 29. He attended Tufts College for a year then entered the U.S. Naval Academy, class of 1920. He then came to the Institute for graduate work in naval architecture and affiliated with our class. Mason resigned from the U.S. Navy in 1926 to become chief engineer of Tidewater Pipe Co., Bradford, Pa. He was also chief engineer of Tide Pipeline Co. and Tidal Refining Co., Tulsa, Okla.; vice-president and president, Tidwater Pipe Co., New York; manager, Sohio Pipe Line Co., Cleveland, Ohio, and retired in 1939.

Harry Nanejian died on July 10. He graduated with our class in chemistry. He then served for a year on the staff of the Chemistry Department at the Institute. We have no information about his professional career.

George Nesbitt died on February 26. He entered the Institute from John Hopkins University and graduated with our class in business and engineering administration. After graduation he joined Union Carbide Co. and became superintendent of the Prest-O-Lite plant, then left that organization to engage in real estate, insurance and banking. He was president, First National Bank of Sandy Spring, Md.; member, local planning committee, Menlo Park, Calif., director, Montgomery General Hospital, Sandy Springs, Md.; and member, Montgomery County Council. He was also a member of the Society of Friends.—**Richard H. Frazier**, Secretary/Treasurer, 7 Summit Ave., Winchester, MA 01890

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Eric Brater, probably the oldest member of our class, was honored at a dinner party in Cleveland, Ohio, August 14th, on the occasion of his 90th birthday. He entertained the 28 guests with a talk of humor and his early life. He emigrated with his parents from Germany to New London, Conn., in early 1900. He worked as a draftsman, steam engineer, and chief engineer on a ship. At the Babcock Printing Press, New London, he realized that he needed a higher education.

He was awarded his S.B. in mechanical engineering and began his career with the White Motor Co., Cleveland, as a technical engineer. In 1973, he joined the General Motors Diesel Division as assistant chief engineer, retiring in 1958.

Eric did not achieve "fame and fortune," but at age 40 became a concert pianist, a prolific watercolor artist and instructor, selling 30 paintings at this year's Lakewood (Ohio) Art Festival. He will be best remembered at the Institute for his contribution to the M.I.T. Archives. Professor E. Neal Hartley, Institute Archivist, in 1967 wrote Eric "after receiving your notes—I could say that I have encountered nothing like them in all the years that I have spent within the walls of universities. I am sure that some day, they will provide scholars of the history of engineering or the history of M.I.T. with rich documentation of teaching-learning activities in your period."

We have a letter from the Vermont National Bank noting that it is the executor of the estate of **Richard W. Steenbruggen** who died November 5, 1984. Dick was exposed to electrical engineering in Course VI and became town agent and grand juror of Vernon, Vt.

A letter from the chairman of the Alumni Fund Board to **Elmer Brugmann** was returned noting that Elmer had passed away May 22, 1986, in Wilmington, Del. He was a patent engineer for the DuPont Co. He attained an S.B. and S.M. in chemical engineering practice and was well-known at the Institute through his wide activities. He was a member of Tau Beta Pi and had been president of the Chemical Society and Executive Committee—also a member of Osiris, Stylus, *The Tech*, Choral Society, Cosmopolitan Club, Institute Committee and other activities.

We have a new address for **Roland N. Black**—1600 Westbrook Ave., Apt. 201, Richmond, VA 23227.

After **Jim MacLean**'s conversation with **Don Moore**, your Secretary dug up the 1974 compilation of our VIers: 85% responded. Our class autobiographies, now in the process of compilation is far below that figure, but we are hopeful, so send yours along to Joe Martori, Alumni Association, M.I.T., Cambridge, MA 02139. They will be retyped, edited and appear in letter-size pages, stapled together.

We have a letter from **Al Roig** indicating that he had renewed membership in the M.I.T. Sustaining Fellows program and was thrilled on a southern hemisphere sea cruise to see Halley's Comet. He left Ft. Lauderdale, Fla., on March 1st, and arriving in Martinique had his first binocular sight of Halley's in 76 years.

Viewing began at 4 a.m. each morning during the 19-day trip. At Rio de Janiero the tail had grown longer, but the Comet itself was no brighter. At Belem, Brazil, the temperature rose to 97 degrees and a 63 degrees air conditioned bus began a gradual siege of flu, which Al battled for three days at Rio and Miami, ending in a 45-day hospital stay in Humacao, much of it in intensive care and lacking full awareness. He lost 18 pounds, is home with constant care and we hope rapidly recovering.—**Russ Ambach**, Secretary, 216 St. Paul St., Brookline, MA 02146

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Milt Salzman reports that in July he took a Love Boat Harmony Cruise along the inland waterway to Alaska followed by a tour of Expo '86 in Vancouver and Victoria with a trip to Spokane and northern Idaho to revisit some hydro projects in which he had once been involved. He then flew to Salt Lake City to attend the SPEBSQSA convention. He had a great time with much congeniality emanating from the Barbershop and Sweet Adeline singers aboard the ship and at the convention events.

A note from **Jesse Maury** brought the news that on July 19, 1986, Margaret and he celebrated their 60th wedding anniversary. They were married on July 19, 1926 in DeerLodge, Montana. They have lived in Montgomery County, Md., for 45 years.

Margaret, a native of Chicago received her undergraduate degree from the University of Chicago and her masters degree from Columbia University. Over the years she taught science in public schools and managed educational programs at the university level.

Jesse, born in Butte, Montana, graduated in mining engineering from M.I.T. and subsequently was awarded a Sloan Foundation Fellowship at M.I.T., under which he received a masters degree in business administration. He worked professionally in many copper, lead, zinc, gold and silver mining areas in the United States. He founded a manufacturing business in Prince George's County and managed it for 20 years. He is currently practicing as a certified public accountant and as a commissioner of the Washington Suburban Sanitary Commission. He was president of the Montgomery County Civic Federation for two years, a member of the Somerset Town Council for five years. They have three daughters and two sons; seven grandchildren and six great-grandchildren.

It is with sorrow that the passing of two classmates must be reported. **Benjamin A. Oxnard** died in Atlanta, Ga., on June 9, 1986. Ben worked in the sugar industry and for many years was vice-president of the Great Western Sugar Co. and resided in Denver, Colo. Upon retirement he moved to Atlanta. His wife Virginia died in 1974. Ben is survived by four children, 11 grandchildren and two great-grandchildren.

Alexander E. Ulmann died at Jagaponack, Long Island, N.Y., on April 23, 1986; and **Harry B. Smith** died in Winthrop, Mass., on July 15, 1985.—**F. Leroy (Doc) Foster**, Secretary, 434 Old Comers Road, P.O. Box 331, North Chatham, MA 02650

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Thanks to **Thomas E. Russell** for a good letter from his home in Naples, Fla. He reads our notes every month and realized that if no one sent in news, there wouldn't be any to report. Tom has had a busy life, and has a great admiration for M.I.T.

Following graduation, he joined the training program for Sullivan Machinery Co. followed by assignments in six cities in sales, ending in Washington. His success moved him to Chicago as central sales manager. "I operated very happily in this capacity until 1944 when the top management of Sullivan was changed and certain policies were introduced with which I could not agree and decided to leave the company. For many years my association with Sullivan was most pleasant. They were honest, conscientious, reliable company and they made good machinery, particularly in coal cutters, hoists, compressors and diamond core drills."

His reputation as a good sales manager, brought him to Caterpillar Tractor and he was given the opportunity to form a "Cat" sales distribution company, Highway Equipment Co., in 1945. Located in Cincinnati, he covered southwest



Robert C. Dean, '26, at age 82 still likes to do architecture, not talk about it. He says, "I'm a little more relaxed now. Every day I used to be the first person in the office and the last one to leave. Now I quit at 4."

Talent, he says, is sometimes more important than education, although he admits that talented people are usually highly intelligent. For Dean, architecture and beauty go hand in hand. And for the architect, he says, beauty often happens by accident. "You sketch something and discover you've created something thrilling." (Photo: George Rizer,* The Boston Globe*)

Robert C. Dean, '26: "Dean of American Architects"

When the *Boston Globe* called Robert C. Dean, '26, the "dean of American architects," the purpose was not to make a pun. At the age of 82, said reporter Marian Christy, Dean is in fact "one of America's most respected architects," and he still works full-time in an office at Perry, Dean, Rogers, and Partners, where he is chairman of the board and senior vice-president.

In his 60-year career, Dean has been a major project architect on Colonial Williamsburg. He designed Furman University, the American Military Cemetery in Cambridge, England, and Macalester College in St. Paul, Minn. His current project is the new American Embassy in Jordan.

Dean says he was a hyperactive child, and he told Christy: "I suppose I'm a hyperactive elder. . . . I'm hooked on architecture. I've never wanted to retire."

Indeed, says Dean, "Boredom is the driving force. I don't want to be bored. So I drive myself."

Furthermore, he told Christy, "the joy of creating something, especially a building, is enormous. It sort of grips you. First you are in a state of dread. You think, 'I can't do it.' Then an idea takes hold. You have a vision.' "

Dean recalled his arrival at M.I.T. in 1922, when, after taking the exams, he was told he was not admitted—weak in French and solid geometry. But Dean didn't take no for an answer, and he finally persuaded the admissions committee to change its mind.

"So there I was," recalls Dean, "the smartest boy in my small Southern school at the bottom rung at M.I.T. I was in a state of shock. Everyone at M.I.T. seemed so much smarter than I. I had great feelings of fear, of frustration. But I also thought I could catch up.

"Later, when I actually came into one-on-one contact with the students at my fraternity, when I saw them close-up, I thought: 'Why, I'm as good as they are.' And that's the attitude I adopted.' " □

Ohio and part of Indiana and Kentucky. He built a plant and added distributorships for eight other earth-moving equipments.

In 1953, a newspaper article states that the Highway Equipment Co. was "one of the first Cincinnati companies to realize the business significance of the government's decision to build an atomic energy plant in Pike county." One of the first executives to tackle the job of supplying equipment for the vast project was Thomas F. Russell, its vice-president. Tom was enthusiastic to build one of the first nuclear power plants.

By 1960, after 15 years, he made a change, sold his interest in the company and moved to St. Thomas for a "short" visit. He stayed about five years. "I got involved there in construction and paving. This grew into two rock quarries on St. Thomas, one on St. Croix plus a full blown hot-mix asphalt plant on a floating barge. We paved all of the downtown between the main street buildings and the waterfront highway, the Sky-line Drive, the road out to the new college, the airports on both islands and supplied the crushed stone for most all the construction. I became disenchanted with the Islands—an ailment that is not uncommon. So I left V.I. and moved to Naples, Fla., where I built a home in Port Royal."

"Looking back at my years at Tech, my favorite instructor was Dean Fuller, english and history. He taught me a love of English literature—particularly poetry—that has persevered to this day. My admiration for M.I.T. has not diminished. We have every right to be intensely proud of our Alma Mater. At least I am and know that I am not alone."

Telephone call from **Carleton Davies** in Charleston, S.C., finds him well and active. He finally gave up his lumber business in January 1986, but still keeps an office in his building that is leased. Carl parted with his big boathouse but still likes to go fishing. . . . During a visit with **Dale Stetson** and wife Pat in Warren, Vt., I found him gradually recovering from a stroke last year. He is able to speak well now and gets around with a cane. They have given up Bed & Breakfast guest from many skiers coming to SugarBush Mt. nearby. . . . **Harold (Bud) Fisher** decided to undergo surgery on his hip joint, from which he has been suffering. Bud reports fully successful operation.

A note from **Russell Westerhof** says that **George R. Copeland** had a massive stroke on June 6 and died on July 6th in Peru, N.Y. Our latest report was in 1983 when their daughter gave George and Ruth a big anniversary party for 135 family and friends. In 1967 George was a mechanical engineer at the Plattsburgh Air Force Base. He spent his professional life with Austin Co. of Cleveland on industrial building design and construction and retired in 1970. They lived in an old stone home overlooking Lake Champlain, had four children and 12 grandchildren.

Henry W. Newell died on February 13, 1986, in Muscatine, Iowa. He and his wife Katheryn lived in Frederick, Md. Henry was a retired civil engineer with the Turner Construction Co. of New York for 42 years before retiring in 1970. His son Henry, Jr. is M.I.T.'66.

Dr. **Carl H. Weis** died on April 22, 1986, in New London, Conn. "A tireless family practitioner who became one of the city's best known and respected physicians." During more than 50 years as an internist and family physician, Dr. Weis built a reputation as a dedicated doctor who would answer calls at any time of day or night. Even after illness slowed him in recent years, he maintained his practice and continued to make house calls to a few long-time patients.

Carl studied biology and public health at M.I.T., was on the swimming team four years and captain Junior year. He graduated from Yale Medical School in '33 and in '34 was instructor of medicine, completing a research fellowship at New Haven Hospital. He opened a medical practice in New London in 1935. For years he was volunteer medical officer to the New London Fire Dept. which nicknamed him "The Night Angel" for his penchant for responding to fires and other emergencies at all hours of the day and night. A fire department helmet and overcoat hung in his home and his personal car was equipped with a two-way radio and assorted equipment such as oxygen and splints. In 1983, he received a plaque from the city in recognition of his fire department work. Cited by the New London Rotary: "There is no one in the city of New London who has not benefited to some degree by the exhaustive effort put forth by this remarkable man and his wife."

His wife said of him, "He just couldn't stop. The whole thing was the patient. He loved his family, but the patients came first, before us, before the hospital or anything else."

He also founded the Tale of the Whale Museum on Whale Oil Row, which includes books, prints, and artifacts of the time when the city was the second largest whaling port in the world, second only the New Bedford.

Our deep sympathy is extended to the widows and families of these fine classmates.—**Joseph C. Burley,** Secretary, RFD #3, Epping, NH 03042; **Lawrence B. Grew,** Assistant Secretary, 21 Yowago Ave., Branford, CT 06405; **Prentiss I. Cole,** Assistant Secretary, 2150 Webster St., Palo Alto, CA 94301

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A local newspaper clipping has informed us of the establishment of the **Arthur A.** and Mary C. **Nichols** Fund, an endowment to "facilitate the upkeep, maintenance and capital improvement of the expansive facilities of the Boys' and Girls' Club" of Waltham, Mass. A reception, marking the occasion and honoring Mary and Arthur, was held early this past summer. You may recall that Arthur (who died in 1968) was chairman of our 35th class reunion held at Harwichport, Mass., in 1963. Mary has continued her interest in and association with '28 activities. . . . Frannie and **Jim Donovan** were particularly interested in the report (July Notes) on **Katherine S. (Salisbury) Hazen**'s part in the work of the American Association of Variable Star Observers since they (the Donovans) have other friends also active in AAVSO. A new headquarters building for the Association was dedicated in Cambridge, Mass., on August 6, 1986. Frannie attended the reception and had an opportunity to chat with Katherine. They agreed that it is comforting and heartwarming to feel that octogenarians are wanted and useful in the work of the world.

The *Technology Review* is issued in two forms: with and without classnotes. Occasionally an alumnus receives the wrong issue and so has no news of his class. This happened to **Max Parshall**; so he called us by telephone and followed up with a good handwritten letter. He asked to have the error corrected (done!) and wrote about their lifestyle in Montana. They have a wonderful social life with many good friends from the academic, medical and military fields. Max had a bad case of the flu last spring but seems to be OK now. Mary is still her chipper self and continues to play and teach piano. Max enclosed a group of photographs showing the beauty of their home surroundings through the seasons. His vegetable garden looks very prosperous and well-tended.

It is with deep regret that we must report the deaths of three classmates. **Joseph W. Gaffney** died on May 14, 1986. The information was received from one of Joe's friends and this was supplemented in a telephone conversation with his sister Alice. Joe graduated in Course XV, business and engineering administration. His business career was entirely with Sears, Roebuck and Co. (head of Purchasing Department) interrupted only by four years of military service during World War II. He was widowed but left a son, one grandchild and two sisters. Those of you who attended the 50th and 55th '28 reunions will remember that it was Joe's talent with the piano that sparked the happy evening singalongs. . . . **Robert E. Murphy** died July 6, 1986. The news was contained in a letter from his wife, Helen, to the Donovans. Apparently Bob had not been well for the previous two years and his final illness developed rather quickly—over a period of only two weeks. Bob was a graduate from Course XV, business and engineering administration. The earlier part of his professional career was in engineering—mostly for American Chicle Co., Flushing, N.Y.—then he established his own consulting, management engineering firm. In later years especially, he gave his time and talents to religious and charitable organizations. He attended every '28 reunion except the 5th, 10th and 55th. . . . **Frank L. Wattendorf** died June 12, 1986. Frank received his masters degree as a member of our class after graduating from Harvard in 1926. He received his doctorate degree from California Institute of Technology where he was a Guggenheim Fellow. Much of his professional work was in aeronautical engineering and research—fields in which he held important positions. . . . To the families of these classmates we extend our heartfelt sympathy.—**Walter J. Smith,** Secretary, 37 Dix St., Winchester, MA 01890

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Henry F. Robbins of Gillette, N.J., sends his greetings to all his classmates. He recently joined the "Octogenarians of Class of '29" and he is proud to be a member. His hobbies include taping audio music and speech and highway and automobile safety rules. He has sent a number of explanations why some states require drivers to have their lights on: N.Y. State police have their lights on for safety, Florida requires lights on when it is necessary to use the windshield wipers, N.J. requires headlights on when visibility is less than 500 feet.

Kenneth D. Beardsley and his wife Barbara celebrated their 50th wedding anniversary by a surprise party arranged by their two sons with 75 guests attending at the Coach Lite Restaurant in Pittsfield, Mass. Upon Graduation, Ken was employed by GE as an electrical engineer working in the Transformer Department and garnered a number of patents for innovative design before his retirement in 1975 after 46 years of service. He also served as an organist at the Zion Lutheran Church of Pittsfield for 46 years, plus rebuilding the organ for six years during his retirement years. He enjoys gardening, camping, photography and music. Music is his second profession, and he is a member of the Berkshire chapter of the American Guild of Organists and the Friends of Tanglewood. . . . I received a note from **Joseph Speyer,** of Newton, Mass. as follows, "Ruth and I are quite well and we were overjoyed becoming great-grandparents recently. Time marches on! I retired some time ago, but Ruth says I have only changed one kind of work load with another. At least I do not have the pressure of keeping schedules of time and task. I do as I please, just enough to keep me busy. Ruth and I are quite well physically and are very proud of the accomplishments of our children and grandchildren." . . . **Frederick D. Merrill, Jr.,** and his wife Carmen of Chatham, N.J., take an annual vacation at Cape May, N.J., to be with their children (two boys) and grandchildren. "The beach and town are beautiful and we look forward every summer to go there. We enjoy a quiet life. It was nice to receive a birthday greeting from the Class of 1929 on my 78th birthday. (I have Parkinson's disease, so my wife Carmen wrote the note for me.)"

Ira H. Abbott of Wolfboro, N.H., lives a quiet life since his wife Martha died a few years ago. His bad knees keep him from pursuing his hobbies of stream fly fishing and golf. He does some motor boating. He is blessed with three children, six grandchildren, and three great-grandchildren. Ira and his wife Martha attended our 50th reunion. . . . **Thomas W. McCue** of Newton Highlands, Mass., was the top caller in the recent LYBUNT Telethon (May 12-15) wining an M.I.T. beer stein and a place in the "Telethon Hall of

Fame." This was a fitting end to a year in which he participated in a record-breaking *nine* telethon nights. He distinguished himself not only by his remarkable attendance, but by his effectiveness as a caller, as his award suggests. He has been an active telethon volunteer since 1981.

Joseph D. Murphy of St. Louis, Mo., writes, "The beautiful poem 'Salutation to Dawn' brings back to me, many, many of the most happy and lovely memories of my life. I remember with deep gratitude my brilliant teacher in architecture, and my talented fellow students (boys and girls) and the School of Architecture on Boylston Street, so spacious and welcoming." Enclosed in his letter, I found a card with the following inscription on the back: "On Thanksgiving Day, November 28, 1935, Ann and I were married in the Redemptionist Church of Kansas City, Mo. Fifty years later, on Thanksgiving Day, November 28, 1985, Ann and I had hoped to quietly celebrate our anniversary in the historic little town of Arrow Rock, Mo. We got as far as Marshall, Mo., where sleet and snow overcame us. We stopped at a pleasant and hospitable motel, the Marshall Inn, where we were greeted most warmly. Even though we didn't visit Arrow Rock, we recommend it for spring, summer and all to our friends."

Jonathan F. McCray of Heber Springs, Ark., writes, "I have known for some time now that I have cataracts growing in my eyes. I have been seeing an opthalmologist in Little Rock and I decided to have a second opinion. So, Isabel and I went to suburban Baltimore in early May to visit her sister, and while there, I visited an opthalmologist in whom I have great confidence. He told me that I have some deterioration of the retina of both eyes due to aging and he did not recommend cataract surgery at this time. I also used this opportunity to visit the speech and hearing clinic at Johns Hopkins and had a hearing test. I have not received the report to date. During the examination, they dropped a little hint that I miss some of the high notes in my good ear, which account for my hearing problems in a room full of people. About a year ago, Isabel told me that the house is too large for her to handle at her age. We put up the house for sale, but it is located on ten acres of land in town and people shy away from the price (all cash). Maybe we will stay for quite a while. Best wishes to you and all our classmates."

I regret to announce the death of the following members of our class: **Arthur A. Jones** of New Bedford, Mass., on December 3, 1985; **Oliver L. Barker** of Portland, Me., on February 21, 1986; and **Nicholas P. Stathis** of Stuart, Fla., on June 27, 1986. Oliver was a self-employed architect, practicing in Portland, Me. He also taught architecture at M.I.T. He resided in Duxbury, Mass., for 30 years and served on the planning board. He was a former member of the Masons and Duxbury Yacht Club. His wife, Frances Love, died in 1978 and a son Peter died in 1981. He is survived by a daughter and six grandchildren.

Nicholas and his wife Theodora attended our 50th reunion and I had the pleasure to see him and his wife for the first time since graduation. He had retired and moved to Florida where he enjoyed the sunny and warm climate. He is survived by his wife, two sons, a grandson, a sister, and a niece.—**Karnig S. Dinjian,** Secretary, P.O. Box 83, Arlington, MA 02174

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From West Baldwin, Maine, **Ed Giroux** reports that he and his wife Mildred are still involved in painting. Mildred's paintings are "impressionistic-often compared to Monet." Ed's paintings are "influenced by my architectural background-representational, detailed, carefully drawn." Ed was disappointed to find that he was the only representative of Course IV at our 55th reunion last year. The Girouxs celebrated their 55th wedding anniversary on June 20th. . . . **Elizabeth Rossman Everett** has difficulty believing that she retired from teaching mathematics 17 years ago. She comments that "time speeds up as one slows down—don't understand that but know I should." Elizabeth keeps busy keeping up with her two Teds, husband Ted Sr. who is a lawyer and Ted Jr. who is a computer expert. . . . Marion and **Bill Dickerman** still live in Manhattan where Bill devotes considerable time to family business. The Dickermans travel a lot, "chiefly to Europe after the tourist season in the autumn." . . . As previously reported, **Ernie Fell** retired as a physician in 1967. He continues to attend medical meetings and lectures and is a member of the Charlton Memorial Hospital Corp. and a trustee of the Fall River Public Library. Ernie gets taken out to lunch once a year by **Maurice (Yicka) Herbert** and hears from **George Barker** each Christmas. He says his "health is remarkably well for an old man of 79." . . . **Dick Foster** retired from Campbell Soup Co. some years ago and moved to Chatham on Cape Cod. He is a Trustee of Medicenter 5 in Harwich, Mass.

We have received a notice that **Leslie Ferrier** died in Raynham, Mass., in March 1986 after a short illness. According to the information at hand, Leslie was a professional engineer who had an impressive career as a designer of power plants in various parts of the world. His first job after graduating in Course VI was as a design and construction engineer for consolidated Edison of New York. After serving five years in the U.S. Army during World War II and emerging as a captain, he spent a number of years working for Creole Petroleum, a subsidiary of EXXON's predecessor, mostly in Venzuela. In 1951 he designed and supervised the construction of an 87-megawatt substation off Lake Maracaibo in Caracas. He retired from EXXON in 1963, returning from Venezuela to reside in Raynham with his Colombian-born wife, Beatriz Serrano Ferrier, who is an artist. In 1967 he came out of retirement to design and supervise the construction for the town of Mansfield, Mass., of a substation for the Mansfield Municipal Electric Department. Upon completion of this plant he was persuaded to accept the job of plant manager and continued as manager until his final retirement in 1974. Leslie was a lifelong member of the Institute of Electrical and Electronics Engineers, past president of the Mansfield Rotary club, a member-director of the Taunton Rotary Club, a corporator of the Morton Hospital, and a member of the Old Colony Historical Society of Taunton. Surviving him, besides his widow are a son, two daughters, six grandchildren and nine great grandchildren.—**Gordon K. Lister**, Secretary, 294-B Heritage Village, Southbury, CT 06488

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Claude Machen wrote, "Sorry I had to miss the 55th but I'm looking forward to 57th and 60th." Claude also sent me a notice of the death of one of our classmates, **Otto C. Kohler**. Otto was 83 years old and a retired maintenance superintendent of buildings and grounds at Mt. Holyoke College.

The Alumni Association also sent the following information regarding deaths of classmates—**Arthur E. Jorjoarian**, who was president of Eagle Electroplating since 1939, 40 Millbrook St., Worcester, Mass., a company which was founded by his father. **Bror J. Grondal** died on May 17, 1986. His address was RFD 175, Bluffs Blvd., Center Ossipee, NH 03814. **D. Jack Allis** passed away on June 15, 1985. His address was 167 St. Nicholas Ave., Worcester, MA 01606. Our class extends our sympathy to their relatives.

No further news regarding our 55th reunion since my last letter. Helen and I are rapidly recovering from our accident after the 55th reunion.

Ben Steverman sends the following news. "I talked with Claude Machen upon returning from the 55th, and am pleased to report that he and Jean are both in good health and enjoying the summer in New Hampshire. Claude says that our Class Treasury is in good shape, although it was dented a little by the expenses involved in our reunion escapades. Many thanks for the great job Claude has done over the years as our class treasurer.

"A note from **Howard Richardson** upon his return from the trip to China again expressed his regrets that he and Evelyn had to miss the reunion in order to make the trip. A bout with pneumonia while in China dampened his spirits, but he's now back home in good health.

"We were dismayed to hear of **Jack Allia**'s death on June 15th. In May, Jack had to cancel his plans to be at the reunion due to a serious heart condition. We had enjoyed Jack and Sophie being with us at so many past reunions. We missed them very much. **Al Coleman** from Florida, and **Allen Wilson** from South Carolina, had to cancel their reservations also at the last minute on doctors orders. We trust that they are back in good health again.

"There were several up-beat letters from those who wished to be at the 55th but were unable to do so because of conflicting plans, but who wanted to convey their best regards to all. These included: **Dick Kropf**, **Jack Lane**, Mid and **Jerry Cook**, Bertha and **George Moy**, Ellen and **Art Bertolett**, **Harry Kamy**, **Arnold Childs**, **Bob Martin**, **Art Smith**, **William Nixon**, **Len Schuttig**, and **Carrington Mason**.

"Drop me a line if you would like a copy of the Directory of Classmates. They are better in your hands than in my basement."—**Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, FL 32757; **John Swanton**, Assistant Secretary, 27 George St., Newton, MA 02158; **Ben Steverman**, Assistant Secretary, 2 Pawtucket Rd., Plymouth, MA 02360

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Al Dietz has been appointed president of the Cardinal and Grey Society for the coming year. Al said he will be willing to serve on our 55th Reunion Committee. Welcome aboard!

F. David Schweizer, '31, from Scotia, N.Y., writes us that his good friend and neighbor **James P. Mills** died in July 1986 after a short illness. He was a manager for Mohasco Corp. for over 30 years. He retired in 1977. He leaves his wife Marion-Bobb and two sons. . . . **Lester Gallup** died on March 5 in Florida. He was a salesman for Rhode Island Tool Co. for more than 35 years. Besides his wife Dolly, he leaves two daughters, four grandchildren, and one great-grandchild.

We are informed that **Frederick B. Walsh** died on February 4 in his home at the White Mountain School, New Hampshire. He served for the Bethlehem Steel Co. as a naval architect and marine engineer in various capacities. In 1949 he started his own business which he sold in 1961. Besides being active as a consultant he was involved with many civic, religious, and educational duties. He is survived by his wife, Virginia Walsh, three sons, two daughters, and three grandchildren.

Perhaps this is a good time for me to write about my business activities and reflect how the business climate has changed in the last ten or 15 years. Our company Lloyd Laboratories, Inc., manufactures and services finishing materials to leather manufacturers (usually tanneries). The new environmental laws take considerable amount of our time. How to reduce the quantity of solvents in our products, how to dispose of hazardous waste, how to issue material safety data sheets with each of our countless products, how to comply with the "Right to Know" laws so that all employees, neighbors, and civic officials know what dangers they may be exposed to—are some of the new problems that this rather small company (sales $3 million) must face.

Because over 80 percent of our shoes and leather products are now being imported, our American leather manufacturers in many many cases had to give up and close their doors. How can Lloyd Labs be a survivor in this climate?

Well, we, through various plans and arrangements have acquired about six of our competitors who were about ready to give up. In our latest acquisition, we agree to make the new company's products for three years at a very minimum price in our factory. They continue to sell their products and realize whatever "good will" income they can get. After three years Lloyd Lab acquires the accounts and makes some side arrangements with a few of the personnel. It sounds complicated—but remember the industry is being decimated and we want to be a survivor if we can.

I have been class secretary for almost ten years. So far I have not missed appearing in each issue. Sometimes my correspondence is thin and its the obituaries that keep me going. Would each of you reading these notes pick up a pen and send me greetings for your classmates. You can add anything more you wish. Nothing is too trivial or mundane.

I assume about 100 classmates will read these notes. I'm betting that 25 will respond. Will I win or lose? The results will be reported in due time. Greetings to you all.—**Melvin Castleman,** Secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33

News is thin this month. We need some more correspondence. Some of you regular letter writers must be taking vacation. When no mail comes, I have to do like Daphne's brother says, "Speck it up!"

Gertrude Lindsay sends word that **Lennox Lindsay** died last spring. **Gardner Hicks**, a retired Civil Engineer with the U.S. Army Corp of Engineers died in Piverton, R.I., in mid-summer. **Jack Allia**, who was with our electrical engineers during his undergraduate days, passed away in Worcester. He was with New England Power for 30 years. Margaret Oldenburg writes that **Preben Oldenburg** died last spring. We have delayed notice that **Fred Walker** died in Albuquerque in 1984.

When we moved to our retirement home five years ago, there wasn't room to keep everything and the *Techniques* and *The Tech* had to go. After 50 years I don't remember as much as I would like. Don't you have a few recollections about those freshman/sophomore battles each fall? Information would be well received.

Get out your "rememberer" and write me some information to be shared with all the others. What were events called—Field Day perhaps. How did the class of '33 make out? Who were our leaders? I seem to remember **Charlie Bell** as one of the enthusiastic ones. Who else? Who went to the affairs last Technology Day? You know who you are and whom you saw. Sit right down and drop me a note. No one has written me yet.

Just as the deadline for news came along, there was a nice long letter from **Neil Hopkins** in York, Pa. He reports their lifestyle has changed this year. Ruth spent a month in a nursing home and he had the operation popularized by Reagan. He is recovering nicely. Good things happen too, as we all know. Daughter Ruth gave the house a good cleaning while his wife was in the nursing home. Neil has tried to reach **Ellery Clark** without success. I guess he is off in his Airstream. A lot of you fellows, drop me a note this month.—**Beaumert Whitton**, Secretary, Cottage 112, Sharon Towers, 5150 Sharon Rd., Charlotte, NC

34

From several sources I have information of the death, on April 7 last, of **Claude P. Beaubien** in Montreal, P.Q. Primarily, it came in a lovely note from his widow, Jeanine. From an accompanying obituary I learned that Mr. Beaubien had spent his entire working career with Alcan. For some years he was in personnel work, then in sales, when Alcan opened its first Quebec City office. In 1949 he became manager of Montreal district sales and in 1958 was appointed vice-president for public relations and advertising; a position he held until his retirement in 1972.

Over the years Mr. Beaubien took part in many local and civic affairs. He was active in the national and provincial chambers of commerce, served three years as an alderman of the city of Westmount, and worked with committees in Montreal supporting the symphonic orchestra and other areas of the arts. In addition to his wife he leaves a daughter, two sons, and six grandchildren.

It is perhaps ironical that a man who seems to have given so much of himself should end suffering from one of our so-far "untouchable" diseases. In her note Mrs. Beaubien tells of his dying of Alzheimer's disease in the hope that "members of the Alumni Association are aware of this devasting illness, how it affects everyone in a family, and the need to fight it on all fronts."

She also goes on to say "Claude was very proud of his M.I.T. days and for many years attended the convocations. Now I have one joy in going to visit your lovely city—that is to see our son Luc ('82) who is now an assistant vice-president of A.R.D. Textron."

I know that Luc Beaubien, when he reads this, will carry our sympathy to his entire family.

A note from "Cash" Belden in Brockville, Ont., had also brought me the information about Claude. He also included some personal items—he and Leta had spent three weeks in January and February at Marco Island, enjoying the warm weather and shelling. While there, they visited Mary and **Ed Geittman** on Sanibel.

Cash wrote, "On our return here we immediately got involved in gardening. We raise all our own flower and vegetable plants from seed, some of which must be started in February and early March. Along with this I manage to get in three nights a week at curling, which is my favorite winter sport. I am still involved in competitive curling, but I don't know for how much longer."

Cash goes on to comment on the fun of International Mixed Curling which involves teams from New England and New York state. Plus, that he is looking forward to the next mini-reunion—whenever and wherever it is held.

Notes for the next two issues will come courtesy of **George Bull**. I'm leaving September 13 on the Quarter Century Club trip to Scotland, then staying on in England for two weeks. This will get me home October 9 and nine days later I'm off to China for 25 days—a Linblad tour similar to the one Bea and **Norm Krim** took and enjoyed so much. Naturally, when I'm in Beijing I hope to be able to see Wing Lem Fu.—**Robert M. Franklin**, Secretary, P.O. Box 1147 (620 Satucket Rd.), Brewster, MA 02631; **George Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20815

35

John Taplin sent me additional information about the Taplin Professorship, on which I reported briefly last issue. Dr. Cravalho who is the first occupant of the chair will be located at the Mass. General Hospital and will be chief of biomedical engineering at MGH. Dr. Cravalho has been a member of the M.I.T. faculty since 1966. John states that he is now spending a lot of his time at the Medical School's Office of Licensing and also working with the Japanese on new energy conservation techniques. In addition to the responsibilities already mentioned John serves as vice-president of National Braille Press, as a member of the Harvard School of Public Health Technology Transfer Committee and as a member of the Research Corporation Task Force for Children's Hospital Medical Center. John is another of our classmates who will never retire!

On June 14th at noon a sleek limousine with dark windows pulled in front of my Waltham rooming house, courtesy of the owner of one of the companies for which I work on a part-time basis, and in I stepped for a trip to Logan Airport while watching the Channel 5 Candlepin Bowling! How do you like that for a start for my trip to Alaska? I'll have to admit that I did not touch ground again until I landed at Juneau the following morning. Well, if you have never been to Alaska, be sure to put it on your must list. It was my first trip and I only saw the southeastern part of the state. The scenery is awesome and breathtaking—rugged, natural beauty of snow-capped mountains and ponderous glaciers. I was told to prepare for rainy days in the 40s. For the first time in years, Juneau had no rain for the five days I was there and the temperature was in the high 50s! I even planned to climb Mt. Roberts which with Mt. Juneau are the backdrop for Juneau. But I lost my interest when the Forest Service said I had to climb with someone who was familiar with dealing with black bears! I stayed with my daughter Janna and her husband who were in the process of opening a small cafe on Front St. With the help of tourists and the locals they were doing so-so but with the end of the tourist season Sept. 15th they plan to change over to a deli-bakery shop. Fifteen large cruise ships arrived at Juneau during my five-day visit, and if you can take the time that is obviously the best way to go, sailing up from Vancouver, B.C.

Upon my return to Seattle I had lunch with Marian, my first wife, and 12-year old Shannon, a granddaughter I have never seen. I spent two nights with my son, Allan James and his family in Lake Bay 60 miles southwest of Seattle. He lives and works a farm at the same time he is holding down a full-time job in Tacoma in charge of maintenance and repair at a large trucking company. His wife Lisa manages a day care center for 15 to 25 youngsters housed in a building they built themselves. Mt. Rainier looms out of the haze 60 miles away to the east over Puget Sound. It is beautiful country covered with spruce and evergreens. Now I am home preparing for a golf match with **Goffe Benson**, **Bob Flood** and **Ken Finlayson** being held at Bob's Winged Foot Country Club, sight of many USGA tournaments, this coming Thursday. It's our substitute for the Class Golf Tourney we had for 25 years! **Art Haskins** should be reporting soon on his Tanzer 22 summer races, but how about the rest of you? What have you been doing?—**Allan Q. Mowatt**, Secretary, P.O. Box 524, Waltham, MA 02254

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At this writing, two months after our 50th, many of us are still enjoying the memories. And in the meantime we have received the group pictures—one of class members and another of the wives—with almost everyone individually identified by president Alice Kimball and her reunion committee. What a job they did!

Also in the mail by now are the 50th-year biographies: to everyone who sent one in, and to others who did not but remitted their class dues anyway. Anyone not falling in these categories may yet obtain one of a few remaining copies in return for sending the dues of $25.

Your new secretary received from **Herb Borden** some great pictures taken from Coach Valentine's launch by wife Kitty as the class eight rowed on the Charles. Speaking of crew, all oarsmen (and there are quite a pack of us '36ers) will relish a story by **Milner Wallace** in the latest newsletter for Friends of M.I.T. Crew. It concerns a freshmen race won against Harvard under extreme conditions in 1933, and involves coxswain **El Koontz**, stroke **Ed Pratt** and Coach Al Dunning. If you are not already on the mailing list, a note to Editor James Bidigare, '78, 659 Green St., Cambridge 02139 will get you there.

After the reunion, **Tony Hittl** and Dotty mosied back across the continent via Canada for six weeks, and then had a houseful of company. Nevertheless he responded promptly to my request for a word to all of you about his 25 years

as class president: "First—my appreciation for the opportunity, and for the cooperation of everyone in our various undertakings. It has been fun getting to know many of you through working together, a closeness that I hope will continue. I'm especially grateful to **Alice Kimball** for her work in holding the class together as secretary and as hostess for mini-reunions; to **Henry Lippitt** for his continuing reminders of the Alumni Fund, and to **Lou Stahl** for guiding us to a Fifty-Year Reunion Gift of over $3,500,000."

I expect to see Tony at the annual Alumni Officers gathering, which is away from home for the first time, meeting in Costa Mesa, Calif. Wife Phoebe Phillips and I will take in the Grand Canyon on the way. In the course of working on Lou's committee, assistant secretary (now) **Pat Patterson** picked up a batch of information from several classmates who could not be at the reunion. His report: **George Donnelly** was in the process of selling his Westbury, N.Y., house and expected to move to Ohio. **Leon Simons** (New York City) and his wife Netti have visited **Cesar Calderon**'s widow a number of times in Puerto Rico. Cesar's daughter has an important position in the P.R. government. Leon continues to be active and is working toward another patent in metallurgy. **Irvin Etchells** had just returned from Florida to Kingston, N.Y. after a visit with his daughter. He reports good health. **William Peters** (Lockport, N.Y.) was recovering from a gall bladder operation. **Art Peel** (Rome, N.Y.) and his wife were planning a trip to a Greek island to see their daughter and husband who are touring around the world by bicycle. Until our phone conversation, Art recalled only one other contact with a '36 classmate when he saw **Bob Worden** briefly in Italy during World War II. **John Obrig** (East Quogue, N.Y.) retired from Trane, Co., is active in AARP and is doing some work for the IRS.

Swimming team members will be interested that Pat, who captained the team in '36, and mentioned doing a little swimming now in his biography, has stepped it up to about a mile a day. He says that this "amounts to more laps than was possible in an entire season when the Institute rented half of the University Club pool a few hours two days a week in the 1930s."

E. Gordon Riley passed on in March. His widow Marguerite wrote from 410 Henderson Rd., Severna Park, MD 21146. Gordon entered from Baltimore Polytech in junior year, and in his career was with Marquardt Corp. and Conductron Corp.—**Frank Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

37

Robert E. Benson, Duck Pond Rd., Locust Valley, N.Y. 11560, has retired three times: as vice-president of ITT in 1976; as vice-president of Equitable Life in 1981; and as vice-president of Merrill Lynch in 1985. He writes, "currently working as senior vice-president and chief financial officer of FINACORPRO N.V. (Neth. Ant.) a subsidiary of COPRO S.A. (Switzerland), may resign soon." Robert is a non-volunteer trustee of DIME Savings Bank of N.Y., president and trustee of IWCA Retirement Fund, vestryman and treasurer of St. John's of Lattingtown, trustee and treasurer of Locust Valley Library, and trustee and governor of Beaver Dam Winter Sports Club. Travels have been to Florida or the Caribbean Islands every winter vacation, sailing, cruising the Cycledes (Greek) Islands; last winter Captiva with some grandchildren. Robert regularly travels to Switzerland; 15 times in the last 15 months, chiefly on business. His wife Elena's main interests are children and grandchildren, bridge games. She is a voracious reader and travels as a delightful companion with the O.M. They have two daughters, three sons, and ten grandchildren. Robert writes, "Continue to enjoy good health, no accidents to speak of and a wonderful wife of 44 years. Have enjoyed over the years reading of the accomplishments and careers of my classmates. Despite a protracted silence on my part, be certain that I recall the years with all of you at Tech with great joy. I would do it again tomorrow (but work a little harder)! In spite of remark above, have no present intention of hanging up my socks—would like to do a bit more consulting work in investment banking. Best to all of you and godspeed!" **James M. Ewell**, 9000 Indian Ridge Rd., Cincinnati, OH 45243, retired in 1979 as senior vice-president and director of Procter & Gamble Co. He is a member of the board and just retired chairman of the Cincinnati Symphony Orchestra, on the boards of the Cincinnati Childrens Hospital and the Cincinnati Nature Center; and is president of the board of stewards of the Indian Hill Church. Travels have been to Italy last September, and New Zealand and Australia on a Royal Viking Cruise. At this writing Bette and Jim were planning to drive around Scotland this August. Wife Bette's main interest is music. Jim was responsible for architect selection, design and construction of Cincinnati Symphony's new summer home, "Riverbend," on banks of Ohio River. It seats 5,600 under roof; 10,000 on sloping grass berm beyond pavillion.

Robert Thorson, your secretary, sold Thor Roofing Co., June 1986. He writes, "I just started working for the family business during summer of 1935—over 50 years ago. Thor was started by my father and uncle. My uncle died in 1935 and my father in 1939, which is when I took over the reins. I will still be associated with the company as a consultant on an every day basis for the rest of this year, and when needed after that." . . . **Walter S. Wojtczak**, P.O. Box 351, Newbury, N.H. 03255, retired in 1985 as senior vice-president of Standard Builders, Inc. He writes, "taking a tour of the Canadian Rockies in September, including the Vancouver's World Fair and may catch the National Alumni Conference, in Orange County, over September 26-28. Am fully retired now. Sold our home in Conn. and now divide our time between Florida and N.H. (The N.H. address is from June 1 to Nov. 1—Fla. address is Nov. 1 to June 1.) Still trying to get our New Hampshire dwelling organized for full-time occupancy rather than as a weekend retreat. What a job to clean out our home of 36 years in Conn. Still have things stored in a half dozen places. Looking forward to our 50th. Saw Curt Torrence, '38 this past winter in Sarasota. He and Minna were cruising Florida in their boat.

G. Richard Young, 1 Cardinal House, Hammersmith Rd., Newport, R.I. 02840, our 50th reunion chairman writes, "The 50th is moving along. We have reserved the Wequassett Inn, Pleasant Bay, Chatham, Cape Cod for June 5th through 9th, 1987. The plan is to leave Boston the afternoon of the 5th following our big Alumni Day luncheon. Pops will be, as usual, on Thursday evening, the 4th. Put these dates into your calendars. The Steering Committee for the Reunion has been formed and as soon as we have been able to assemble a sufficient number of the committee, there will be more firm definition of specific events we wish to include in the whole program." I regret to report the deaths of **Eric O. Moorehead**, 223 Avenida Barbera, Sonoma, CA 95476 on May 28, 1986. He is survived by Mrs. Eric Moorehead. I also just learned of the death of **Sophie Ginsburg Gould** who died in May 1985. She is survived by her husband Prof. Emeritus Bernard S. Gould class of '32, 25 Cotsweld Road, Brookline, MA 02146.—**Lester M. Klashman**, Assistant Secretary, 289 Elm St., Apt. 71, Medford, MA 02155; **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, MA 02155

38

At the time of writing this, it seems pretty clear that we'll have a new income tax bill. The point is this: we are about half way to our goal for our 50th Class Gift, and now is the time to act, since the tax deduction in 1986 will probably be greater than subsequent years—and don't forget that a gift in appreciated securities counts too!

On another note, **Al Minott**, living in Granada Hills, Calif., reports that he is still working as a mechanical design engineer on the Intermountain Power Project of the Los Angeles Department of Water and Power. . . . **John Argersinger**, living in West Hartford, Conn., and retired from Combustion Engineering, has been named the Connecticut state coordinator for the ASME. As state coordinator, he serves as the Society's "man in the Capitol."

We belatedly received word that **John Glass** passed away last December. John had resided in Essington, Pa.

Finally, Sandy and I extend to all '38ers best wishes for the holidays, and, of course, a happy and healthy New Year.—**A.L. Bruneau, Jr.**, Secretary, 663 Riverview Dr., Chatham, MA 02633

40

The Center for Technology and Policy at Boston University received a major $100,000 grant from the Bell and Howell Co. which was made in memory of the center's late founder and director, **J. Herbert Hollomon**. The grant establishes three post-doctoral fellowships to support work in the areas of industrial innovations, industrial research and productivity and technology and work. In announcing the grant, Bell and Howell Chairman Donald N. Frey said, "we believe that the work Professor Hollomon carried out in these areas was seminal and vital and should be continued, but updated with the times."

Sorry to report the death of another of our classmates, **Herman Bartholomay** of 7248 N. Via Nueva, Scottsdale, AZ 85258 on April 3, 1986. No further information.



A. W. Beucker

A.W. Beucker of Beloit Manhattan, Inc., presented a technical paper entitled "Roll Coverings—Present and Future" during the 128th meeting of the Rubber Division, American Chemical Society in New York last April.

A very nice letter from **Gary Wright** tells of his trip to the San Francisco area, during which they drove up through the wine country of Napa Valley. Inquired about **Charlie Edwards**, but with no luck. They thought it would have been fun to drop in and have a toast of Charlie's wine to the Class of '40. Maybe next time.

The Wrights were also hosts to Jeanette and **Beano Goodman** and Sally Bittenbender for a few days last May. Sad to learn that Jeanette died about a week later. The Class of '40s sympathy goes to Beano and his family.

Thanks to all of you for your calls, your letters, and to you, **Jack Danforth**, for your visit. Guess old friends are still the very best.—**Donald R. Erb**, Secretary, 10 Sherbrooke Dr., Dover, MA 02030, (617) 785-0540

41

Our president **John Sexton** sends the following report: "Ninty-one members of the class of '41 attended part or all of our 45th reunion activities held on June 3-7, 1986, at the New Seabury Re-



Dr. Robert Shaw, '42, offers his support to First Lady Nancy Reagan for her campaign against drug abuse. The occasion is a reception at Bentley College, Waltham, Mass., to recruit professionals and experts to help counter the widespread use of drugs in this country.

sort on Cape Cod and on the M.I.T. Campus in Cambridge; and reports both oral and written add up to the fact that our two-part reunion was an outstanding success in spite of some rain during the Cambridge part of the reunion.

New Seabury took good care of us. There was plenty to do in the way of golf, tennis, a whale watch, and a visit to Woods Hole Oceanographic Institute; and the meals at New Seabury were great even though a little more expensive than some of our classmates expected.

"We are delighted that the Alumni Association has chosen our **Joe Gavin** to head the Association for the next year. We promise to help Joe in any way that we can in this endeavor. The 45th reunion committee made up of **Dave Howard**, **Joe Dietzgen**, **Leona Zarsky**, and **John Sexton** want to thank you classmates for the enthusiasm and cooperation that made us realize that our efforts were appreciated. We also want to espcially thank Eliza Dame and the entire Alumni Office for their invaluable assistance along the way."

Our wonderful **Robert Wallace Blake** writes from Seattle: "First a card from **Charlie Butt** from Henley, England, telling of the joy of watching his son row to the championship fours—without cox'n. Next came a letter from **Connie Nelson** saying he hoped to come out next month to attend the new Seattle production of Wagner's Ring. He enclosed a *Washington Post* article about Charlie and the 20th reunion of his 1966 W&L crew that went to Henley but didn't quite win. Another item in the mail was a wedding announcement from Maude H. Halstead and Lewis H. Allen. Lew was M.I.T. Course XVI, '38, and a long-time associate of mine at Pan Am. He retired as vice-president and chief engineer in 1981. His wife Barbara died about 18 months ago. Maude is the widow of G. Chappel Halstead M.I.T. Course XV, '40, and a Phi Kappa Sigma fraternity brother of mine. He died in 1978 after a long illness and after a long career at ALCOA Steamship Lines, where he rose to be chairman and chief executive officer.

"Over the 4th of July I flew to Tampa to attend the 49th reunion of Balboa High School (Canal Zone) class. Two members of this class are also M.I.T. classmates: **George Young** and **John Stadig**. George left in 1939 to go to military academy. Both are well and live in southern California."

Allen P. Winsor died in May after a long illness. He was the husband of Barbara Jean (Thompson) Winsor. He was born in Boston and continued to live in this area and was an engineer with Morse Cutting Tools until retiring in 1979. Allen was a life member of the ASME and a Navy Seabee Veteran. He is survived by his widow and two sons.

Chester N. Haset left this note: "Just before leaving for our reunion, I received this letter from **Quentin Wald** from Club de Mar, Palma de Mallorca, Espana. Quentin says he is sorry to miss the reunion, but is about to depart to cruise the Mediteranian headed for the Greek Islands. He is on his new 30-ft. sloop, the *S.Y. Anaximander*, named for the Greek mathematician, 850 BC. He'll be joined by his daughter and friends from time to time. Quentin expects to winter on Crete, while resuming his travels in Europe—no plans to return. (I have his address in Greece and in Spain, if anyone wants to catch him, let me know.) P.S. Quentin and I grew up on Long Island, just a few miles from each other and after war in 1947 took off from Bermuda in a 37 ketch, going to Connecticut. Unfortunately we were caught in a hurricane, 100 miles from Bermuda. Had a helluva time for five days—lost both masts overboard and were fortunately picked up by the U.S. Coast Guard. Quentin will definitely come to the 50th reunion and also the 75th."

Chet Hasert added a lot of fun to our reunion. All the best to Falls Church, Va. Send your thoughts to: **Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02365

42

An article from the *Fitchburg Leominster Sentinel & Enterprise* (Honest Injun—I wouldn't kid you—that's the name of a newspaper!) dated March 5, 1986, has a long and laudatory outline of **Bob (Hawkshaw) Shaw**'s life and times and informs one and all that he is running for the Mascenic (N.H.) school board. Have not heard further, so Hawk, do let us know whether you won and if so, when do you plan to close all the schools?

Final note on the invasion of the United States by **Charlie Stempf**. He did get back to Australia which triggered a letter from him dated "4 July 1986 (known to us British as the Rebels' Picnic)." He did get to the reunion of his World War II ship, the USS Drum, saw the **Seeleys**, **Bruckmans**, **Hendersons** and the New Ipswich (N.H.) **Shaws**. Charlie does not mention whether he plans to make another trip to the States during the rest of his natural life!

Super-brief bit from **Herman Lorence**, reported verbatim, "have a VW camper which gets used on weekends when not sailing in 28' boat." Herman, does that really mean that you use the camper on weekends and sail the boat all week? Sounds like a pretty classy schedule. Now we are completely bereft of news. This is an urgent plea to one and all—WRITE NOW!—**Ken Rosett**, Secretary, 191 Albemarle Rd., White Plains, NY

43

I have had no direct communication from **Virgilio Barca**, president-elect of Colombia, but news reports say he is meeting with leaders of other nations to discuss the international drug problem, which strongly affects his country. We wish him well.

From Connecticut comes word that **Ward J. Haas** of Fairfield has been named president of Industrial Research Corp., an agency of Bridgeport University which sustains itself by taking research contracts from industrial companies. Ward has directed major R and D operations for more than 20 years.

I must sadly report the death of another classmate, **Herbert Greenewald, Jr.**, in Columbus, Ohio, last December 2. Herbert was president of Greenewald Associates Inc. and of Metallurgical Engineering R&D Co. He held a number of patents in the fields of metallurgy and ceramics. We extend our sympathy to his widow Joan and their three children.

Gil Monet and wife Marion have warded off the dreaded Secretary's Phone Call by writing a letter from their home in Wilmington, Del. For three years the Monets have been retired from duPont and Sun Oil, respectively. From what they say, it's been nothing but play, the livelong day. That is, M. bows the cello and strums the harp while G. tootles on the recorder (sometimes called the cacophone). While resting his fingertips Gil also does portrait sculpture and fashions stained glass windows. In addition, he and Marion are avid fans of opera, ballet, and museums. He wistfully wonders where all the '43 alumni are when the M.I.T. club meets in his area.

Well, there you are, classmates. If Gil Monet can find the time to send me a letter, anyone can. Don't delay, do it today.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

44

Edward P. Radford writes that after two years in the Orient, mostly at Hiroshima studying the atomic bomb survivors, he and his wife have returned to England. He is now officially retired, but between getting their house organized and numerous television appearances after the Chernobyl disaster, he has been busier than usual. He hopes to settle down to writing in due course. His wife Jennifer is off again to Singapore for two months of consulting for the World Health Organization. . . . Had a brief note but not much news from **Robert Nicolait**. He was interested in contacting his roomate **Jim Ruoff**. Bob is president of his firm Robert Nicolait and Associates Ltd. in Belize City, Belize. We'd like to hear more from Bob perhaps with his observations on what is going on in the hotbox that Central America has become.

Your reunion committee met at **Andy Corry**'s home on Cape Cod on August 13. Present were: Ruth and **Norm Sebell**, Jane and **Lou Demarkles**, Jane and **Bob Barnaby**, **R.J. Horn**, **Melissa Teixeira** and **Jim Baird** and **Andy Corry** and his bride of six weeks and five days, Diane Kinch. It was decided to go ahead with a mini-reunion in Dearborn, Mich., on Friday, May 8, and Saturday, May 9, 1987, under the general auspices of **John Burdakin**. By the time you read these notes you should have received detailed information via direct mailing. If you haven't received this information, please let us know as the cutoff date will be in the early spring. John promises a grand time and we are excited by the prospect of strengthening ties with our Midwest members of the class of '44. It's also not too early to be thinking about our 45th reunion 1989. Let us know of your ideas.—**Andy Corry**, Co-Secretaries, Box 310, West Hyannisport, MA 02672; Jane and **Lou Demarkles**, 53 Maugus Hill Rd., Wellesley, MA

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Mid August and champing at the leash to get on with the Vermont trip next month. Not much news at this point (so what else is new) but it's understandable since we'll be letting it all hang out very shortly. Anyhow, what I did get was a dandy letter from old roomie, **Al Little**, who has lived in Media, Pa. (one of my old "parking places"), the last 27 years. Along with his short letter he sent a copy of his fascinating bio he had submitted to the 40th reunion archives, so those of you who attend will probably have read it and/or talked to Al as I certainly hope to. If he doesn't make the reunion, he has good reason. His wife, Marian (Swarthmore '48), is seriously ailing. The other thing I received, like everyone else, presumably, was Prez **Jim Goldstein**'s Reunion memo. For those possible few who didn't get the word, the Class Gift, thanks to Jim, **Ernie Buck-**

man, and the whole dang committee, was a remarkable success. For the youngest and almost smallest class in this century we came within a few thousand doleros of achieving our goal of 1.5 mega bucks. It was done through a 68.6 percent of the Class participation, an all-time record. Now that's something you can take home and clutch to your bosom. "Way to go, Gang!!"

Remember I'll be reporting on the reunion experience in next month's *Review*. Look for a two-pager.—**Jim Ray**, Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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Our fabulous 40th is coming closer, and closer, and even nearer is the end of this year of the old tax law, 1986. Contributions and pledges to our class reunion gift are building, but we need more momentum if we are to complete our Professorship. Yield to the impulse and send yours. The proposed new tax law may make it much more advantageous for you to make your contribution this year rather than waiting until 1987. Remember: contributions toward our Class of '47 Chair will also count toward the Institute appeal for funds for its core needs. This, of course, includes pledges of contributions. Send in those appreciated securities (which will be appreciated after receipt, as well) and you won't have to look up to see how much you paid for them. Great time saver.

Last May and June **Arnold Judson** presented a one-day executive institute for Boston University in both Boston and New York. Titled "Making Strategic Plans Happen—At Last!," Jud says it presents an approach "that takes strategic plans off the shelf and puts them to work." . . . **John Dangl** has moved to Maryland and joined Litton Amecom in College Park as staff scientist. . . . **Ken Amer** has recently retired after 32 years with the McDonnell Douglas Helicopter Co. (formerly Hughes Helicopter). He held the positions of manager of technology and chief scientist prior to retirement, and will stay on as a part-time consultant. His honors include recent selection as a McDonnell Douglas Engineering and Research fellow, and the American Helicopter Society's Klemin Award and an honorary fellowship. The Amers still live in the Westchester area of Los Angeles, and look forward to having more time for travel and recreation.

Robert Whorf died in April. At the time of his death he lived in New Hampshire and owned the management consulting firm Robert Whorf Associates. After M.I.T., he received a master's degree from Columbia University and studied for a doctorate while teaching at Yale. He was a member of the Harvard Philomorphs Group, which is concerned with higher mathematics. His special interest was solid geometry. He was in the U.S. Navy in World War II. He leaves his wife, mother, three sons, and a sister. . . . **Blair Neil** died in April. He lived in Richmond, Va. His widow is Betty S. Blair. . . . **Harold Ytredal,** of Seattle, Wash., also died in April. . . . **Lewis Morton,** president of Techniques Inc., Englewood, N.J., died in March.—**Virginia C. Grammer,** Secretary, 62 Sullivan St., Charlestown, MA 02129

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Dan Fink was awarded the NASA Distinguished Public Service Medal for his services as chairman of the NASA Advisory Council.

The Distinguished Public Service Medal is the highest honor given to non-NASA individuals. Dan was recognized for his leadership of NASA's advisory bodies, which have been instrumental in stimulating the program for shuttle flights of private citizens, organizing the commercial use of space, and providing the definition of the new earth science program. From 1963 to 1967, Dan was deputy director of defense research and engineering for strategic space systems and assistant director for defensive systems.

He joined the General Electric Co. in 1967, where he was vice-president and general manager, Space Division; vice-president and group executive, Aerospace Group; and senior vice-president, corporate planning and development. He retired from GE in 1982 to establish his own consulting firm.

Carl Accardo has joined the staff in the M.I.T. Industrial Liaison office. Corporate members of the Industrial Liaison program benefit from research and teaching done at M.I.T. Carl will look after the interests of nine Japanese and several American firms that are corporate members of the program. Carl visits the member firms to learn of their interests, and he provides them with information about their opportunities to share in developments at M..I.T.

Carl and his wife have four sons and two daughters. Two of his sons have started their own company working out of the family home at this time.

Art Teager and his son, Robert, were killed in a small plane crash near West Milford, N.J., in May 1986. Art was president of the International Loose Leaf Co. in Middlesex, N.J. He commuted from his home in Somerset, N.J., to Hanscom Field in Bedford, Mass., where his flying school, Patriot Aviation is based. Our sympathy to his wife, Gloria, and their surviving children and grandchildren.

After **Bob Ormiston** retired from AT&T where he spearheaded programs to computerize trouble-shooting of long lines, Bob formed a consulting firm in a related area. His business has kept him plugging away for the past year without a break until this summer's vacation. He and his wife visited their son in Santa Barbara at the beginning of a west coast tour. After stops in San Francisco, Oregon, and Vancouver, they went to Banf for views of Lake Louise and the Canadian Rockies. In the fall Bob will attend an IEEE technical conference.

I spent most of 1981 evaluating several business alternatives. By the end of the year I committed myself to developing a business as a manufacturers representative. My total income is not setting any records, but it is fun to see major increases each year. At the present rate of growth, 1991 should see excellent results in my total income. Some of the products are repeat sales of filter cartridges, others are sophisticated vacuum systems for thin film deposition on semiconductors and optical devices. Also, I represent an on-line process controller using a computer to automate the vacuum system operation.

The advantages of your own business include two trips to Himalaya and three to the San Francisco area, and tax preferences. The total hours worked is not much different than any other occupation, but the advantage is the ease of scheduling when you work and when you play. Another advantage of working alone is that less time is needed for office politics and similar administrative matters. Companies that you represent have one or two meetings per year that are mandatory. This allows them to let off steam about your performance. I plan to continue as a representative for many more years.—**Marty Billett,** Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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James Clarke McAllister retired from McDonnell Douglas Corp. in April after nearly 36 years of service as an engineer and manager of a wide variety of projects in flight test instrumentation and corporate telecommunications. He plans to solicit a small amount of consulting business but, so far, retirement has been so great, he doesn't know how serious the self-employment business will become. Jim and his wife, Hilde, spent three weeks on a self-guilded tour of Holland, France and Belgium. They saw no problems traveling in Europe this year and found the lack of tourists a benefit.

E. Frederick Wheelock, professor of pathology and laboratory medicine, Hahnemann University, Philadelphia, was one of the featured speakers at a reunion celebration of The Rockefeller University Hospital on May 7, in New York City. The event celebrates the University's 75th anniversary. Dr. Wheelock was one of ten speakers selected from among all the Rockefeller alumni who have done outstanding research since leaving The Rockefeller University. At Hahnemann, Dr. Wheelock is also director of the graduate student program in the Department of Pathology. He is the recipient of a $566,782 grant from the National Cancer Institute to study tumor-dormant states in animals and men. A 1961 Ph.D. graduate of The Rockefeller University, Dr. Wheelock received a medical degree from Columbia University College of Physicians and Surgeons in 1955.

Effective July 1, Professor **Robert W. Mann**, known internationally as a pioneer in the fusion of engineering and medicine, was named director of bio-engineering programs at the Whitaker College of Health Services, Technology and Management. Dr. Mann is Whitaker Professor in biomedical engineering in the Department of Medical Engineering and will continue teaching and research activities in that department. He is nationally recognized for his leadership in engineering design education and for his pioneering applications in biomedical engineering. These include several sensory aids for the blind: computer programs to translate inkprint into braille, a computer-controlled braille printer, a telephone switchboard with braille symbols for operation by the blind, and a series of ultrasonic aids for moving around without the use of sight. He then turned to the mechanical problems of the amputee and led fundamental work in the development of an upperarm prosthesis controlled by the users's nervous impulses. Two prototypes—the Boston Arm and the Utah Arm were the results. It was recently announced that a device developed under Dr. Mann's direction had provided the first measurements of pressure in the hip joint ever made in a human. The device, an instrumented endoprosthesis, was implanted in the hip of a 75-year-old woman by surgeons at Mass. General Hospital, with whom the Professor has collaborated for many years.

Professor **Frederick J. McGarry** was the author of a technical paper entitled "Rubber in Cross-linked Glassy Polymers," presented during the 128th meeting of the rubber division, American Chemical Society in New York City, N.Y. last April.

We regret to announce the death of **Roy W. Jenkins** who died on May 3.—**John T. McKenna, Jr.**, Secretary, 9 Hawthorne Pl., 10-H, Boston, MA 02114

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Change comes whether we want it to or not (generally we don't), and if we are wise we will try to anticipate and direct it. **John Rydz**, vice-president for technology at Emhart Corp., has written a book, *Managing Innovation*, based on his thirty years of experience in doing just that, to help us cope with change by innovating. Illustrating his points with tales inspirational and tales cautionary, from events he lived through at RCA, Nucor, Adressograph-Multigraph, Diebold, Singer, and Emhart, he does a fine job describing the opportunities and pitfalls attendant on bringing new products to market. Of course, no book can tell how to solve particular problems, but Rydz describes ways of thinking about one's organization and evaluating the status of projects that have helped him in arriving at solutions by identifying the problem to attack, or the proper resources to attack it. From Rydz's account, there do not seem to be any substitutes for observing, understanding, and thinking, as well as acting. His book may inspire one to try doing these things a little

better.

A press release from Temple, Barker & Sloane, a management consultant firm for which **Stan Buchin** is a senior vice-president, has Stan describing future patterns of consumption for household products. Noting such trends as the decline in the number of full-time housewives, he predicts that people will choose to pay for convenience in products and services, because they will need to save time, and can afford to pay for time-saving appliances and products. Stan seems to be predicting the present, but if his clients are living in the past, they may find that helpful.

Another press release, from Stanford, describes the work of the Center for Reliable Computing, headed by **Ed McCluskey**, at Stanford's Center for Integrated Systems. Ed and his group are trying to find better ways to tell if integrated circuits are misbehaving, both before and after they are installed in computers. One way this is done is to build test circuits on the device itself. I was interested to learn that manufacturers are reluctant to tell customers how to use the test circuitry because of the difficulty in updating documentation for designs and procedures that change frequently over the course of a product's life. Change definitely has its drawbacks.

A pleasant change for **Francis Spinelli**, of Meriden, Conn., was his promotion to senior vice president of Suisman and Blumental, Inc., where he is responsible for buying aerospace metals. His firm apparently buys and resells these metals to the aerospace industry.

May at least some of the changes confronting you also be pleasant ones.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301



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Arthur Tang, vice-president of Tang Data Corp. in Framingham, Mass., was quoted at length in a feature article in *Mass High Tech* last spring. His company, founded specifically to develop wafer scale products, has been prominent in the semiconductor technology field lately. . . . **Bill Eccles**, professor of engineering at the University of South Carolina, had his electrical and computer engineering textbook, *Microprocessor Systems: a 16-Bit Approach*, published last year by Addison-Wesley. The book is doing well, and Bill is hard at work on a new textbook. . . . **Bob Trexler** is president of both Dominion Computer Services and Visual Learning Technology Corp. in Virginia. His companies develop and produce visual learning media for industry and the government.—**Edwin G. Eigel, Jr.**, Secretary, 33 Pepperbush Lane, Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

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Well, by now everyone knows I have returned to the East Coast. It was not because there was no news from all of you in the West, but **Bob Greene** claims I goofed up his grand strategy. However, I will continue to be the co-secretary—with a new location.

Unfortunately the first piece of information is the sad news that **Arthur Oberton** died on April 18. He was a consulting engineer for the Frontier Construction Co. in Toronto, Canada. Arthur was a member of the Society of Civil Engineers and a registered professional engineer in 20 states. He is survived by his wife, four children and two grandchildren.

Word is out that **Charlie Prewitt** became the director of Carnegie Institution's Geophysical Laboratory on July 1. He was professor of earth science and materials science at the State University of New York at Stony Brook. Charlie has three degrees from M.I.T., S.B., S.M. and Ph.D. in crystallography and mineralogy. He has been at SUNY since 1969 and has been associated with many professional organizations plus has been on many visiting professorship assignments: the H.C. Orsted Institute at the University of Copenhagen in 1982 and Arizona State University in 1983. Also in 1983 Charlie received a fellowship from the Japan Society for the Promotion of Science Research. Just for the record Charlie is a fraternity brother of mine and a great guy. Congratulations Charlie!

Sandy Goldman sent a nice letter to all his classmates that I decided to quote verbatim: "At the start of 1986, I established T-MAC, the Technical Management Advisors Co. Our management services include medical practice operations, company and product evaluations for prospective investors, five short-courses relating to excellence in technical operations, and promotional work for professional practices. I've been delighted with business growth; I guess T-MAC is filling a need in assisting professionals in the marketing of their services in today's competitive climate.

"Mary-Glenn (my wife) has been appointed as assistant director of corporate development at the Boston Symphony Orchestra. She's in the development (that means fund raising) office of the BSO; we see many concerts, indeed. Daughter Abigail was a voice student at Tanglewood last summer.

"We and four children now living in Sharon, Mass. I'm still doing a good deal of consulting in the marketing of medical equipment, which effort keeps me on airplanes a good deal. Oh, how those frequent-flyer points pile up!"

Word is out that **Charles Pickering** was in a four-way race for a seat on the board of selectmen in West Bridgewater, Mass. Charles is the incumbent and has held the seat for three years. The article covering the election stated that Charles operates his own company, C.A. Pickering Associates and is a professional engineer. He is married to the former Dorothy Bourget and they have seven children. As a selectman he is the town's delegate to the Old Colony Planning council and a member of the Plymouth County Selectmen's Association and presently treasurer of that organization. Charles was town engineer from 1962 to 1965 and served as the town's consulting engineer and land surveyor. He was elected to the position of fellow in the American Society of Civil Engineers in 1984, the highest active membership rank and an honor bestowed only upon a small portion of the membership. No word was received on the results of the election but hopefully our man was victorious.

That's it for now. I notice all the news I received was from East Coast people so maybe the action is on this coast after all. I expect the West Coast alums to challenge this statement.—**Robert P. Greene**, Co-Secretary, 37 Great Rock Rd., Sherborn, MA 01770; **DuWayne J. Peterson**, Co-Secretary, 201 East 79th St., New York, NY 10021

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Paul W. Abrahams was petitioned onto the ballot and elected as president of the Association of Computing Machinery. ACM is the oldest scientific and educational organization in the computing field with a membership of some 70,000. Paul makes his living as an independent consultant in the computer field in the woods of western Massachusetts (Deerfield) which he finds to be a richer habitat than the big city, especially when it comes to hunting wild mushrooms. Chaulk up better lifestyle to the microcomputer. . . . **Curt Burrowes, Jr.**, started a new venture making "Fascinations" (gift items), some based on old 8.01 labs. (See what happens when you don't dry-lab it.) Curt still operates Burrows Research and is involved with the operation of a machine shop started by his son. . . . **John Cronin**, president and owner of the Ideal Products Co., Worcester, has been elected to the Providence and Worcester Railroad Co. board of directors. Before leading Ideal Products, John worked at Wyman-Gordon Co. as a metalurgist and quality assurance engineer. He also attended Assumption College and Clark University for further study in business management and accounting, and is a director of the South Worcester Kiwanis Club.

William R. Dickson, senior vice-president of

PHOTO: DAVE GRAHAM, '87

Ray, '72 (far left) and Tom Magliozzi, '58, known to their listeners as Click and Clack, the tappet brothers, host the weekly radio call-in show, "Car Talk" from Boston University's WBUR-FM.

Advice for Auto Phobics

"How do you know when it's time to give the car up?" asks a caller. "When the repair shop has a rubber stamp with your name and address on it," quips Ray Magliozzi, '72, who runs the Good News Garage in Cambridge, Mass.

As co-host with his brother, Tom Magliozzi, '58, of WBUR's radio show, "Car Talk," the two dispense both good humor and useful information on everything from tips about buying a car to intricate details on specific repairs. Their relaxed, easy manner inspires confidence and demystifies a subject that most people know little about.

Some of the Magliozzis' helpful hints include:

☐ *New or rebuilt parts?* Consider the cost of the labor. There's always a risk involved with buying rebuilt parts—some are good, some aren't. If the new part costs is $15, the rebuilt $9.95, and the labor $200, go for new.

☐ *Cost of a clutch job?* About $450, and clutch replacement is usually necessary by the time a car has been driven 50,000-70,000 miles. Often, clutch wear is caused by bad habits. These include riding the clutch, downshifting excessively, keeping the clutch out while waiting at stoplights, and using the clutch to hold a car on a hill.

☐ *Standard vs. automatic transmission?* Manual transmissions, long touted for lower cost, superior gas mileage, and mechanical simplicity, according to Tom Magliozzi, aren't quite the bargain they're cracked up to be. The additional cost of automatic transmissions, he claims, is made up in smaller repair bills over the life of the car and superior resale value.

"Nobody understands that carburetor . . . only four guys in Japan, and we won't give them visas."

☐ *Is it better to buy a new or used car?* "If you buy a used car that's been checked out by someone who knows how to check out a car ($50-$100), you're as safe as if you bought a new car," says Magliozzi. And the actual cost for maintaining a good used car is minimal compared to the cost of new car taxes, insurance, and interest payments, he adds.

"It's obvious the Magliozzis went to M.I.T.," says a frequent listener. "You can tell that the way they analyze and explain problems. They know a lot about physics and chemistry."

"Car Talk," currently aired from 6 to 7 p.m. every Saturday and Sunday, is so popular, with an estimated 11,500 listeners, that Ben Roe, assistant general manager of WBUR, is working to make it a national program.—*Sandra Knight* ☐

M.I.T., was elected to the board of directors of High Voltage Engineering, an international company that provides specialty wire, connectors, communication devices, plastic insulation, medical tubing, and research for utility and construction fields. Bill has also been involved in government in his home town of Framingham, Mass., and with his wife Ann was active in the 30th class reunion. . . . John E. Sirmalis is associate technical director for submarine warfare at the Newport Underwater Center in Newport, R.I. In this senior management position, John oversees about 800 civilian scientists, engineers, and support staff. He earned an S.M. in mechanical engineering at M.I.T. in 1958 and a doctorate in the same field from the University of Rhode Island in 1975, and resides in Barrington.

The 30th reunion was most gratifying with 66 classmates in attendance along with some 70 guests. It was great to hear composer John Williams direct his own music, to rough it at the Astor Beechwood Cottage in Newport, and to make plans to meet again soon (which means five years hence). The reunion committee is to be acknowledged, but especially the work and effort of **Ronald Massa**, chairman, and his fellow worker **Leigh Moore** (what a fellow). The class momentos were again distinctive and special. Last heard the suitably embossed wine cooler bags and etched glasses were still available with DUI indemnification card via the (617)229-7844 hotline.

Unofficial tabulation indicates that **Nick Biwer** literally flew in the farthest from Qatar, complete with suitable flight personnel. Nick was overheard discussing the possibility of setting up a United States-based construction firm. Carmen and **Demetrio Calenkeris** came in from Panama. (We did miss our Venezuela representatives.) The best dancers have to go to Josie and **Paul Cianci** and Dianne and **Tom Hoffman**. (Believe this is related to smooth sailing and/or Oscar Headland foot training.) The Greenest Alumni noted were Mary and **Robert McGillicuddy** and Dorothy and **Harold McKittrick**. The most opportunistic alumni proved to be Renata and **Warren Briggs** who decided to have their screws fouled-up alongside in Newport rather than on the open waters. **Gideon Gartner** was acclaimed the partner of the reunion. The most photographic were Ruth and **Lloyd Beckett.** Priscilla and **Phil Trussell** provided the most unused athletic equipment. (Where have all the Jaques gone?) Tennis, sailing, swimming, and walking provided to be the most active sports.

More significa on the 30th reunion should be forthcoming via notes from **Bill Northfield, Warren Briggs,** and others. Keep those letters, press clippings, and other interesting notes flowing. News is the life-blood of your class notes.

Your class officers for the next five years are as follows:

Board of Directors: **Warren Briggs, Bill Grinker, Bill Northfield,** and **Micky Reiss**.

President: **Ronald Massa**.

Senior Vice-Presidents—Reunion: **Lloyd Beckett** and **Ted Korelitz**.

First Vice-President: **Larry Goldberg**.

Vice-Presidents: **Herb Amster, Ed Baker, Roger Borovoy, Peter Dulchinos, George Garfinkle, Gideon Gartmer, Margie Cohen Gilson, Richard Jacobs, Ralph Kohl, Phil Trussel, Sven Vaule, Andy Viterbi, Harris Weinstein, Merlin Lickhalter,** and **Paul Lempel**.

Treasurer: **Klaus Kubierschky**.

Co-Secretary: **George Brattin** and **Irwin Gross**.

Class Agent: **Walter Frey**.

The long list of vice-presidents elected was motivated by the desire to have class officers in various regions of the United States, so that they could be available for class functions as necessary. Consider the option of getting involved yourself.

Please take the opportunity to drop **Robert Kaiser** and **Caroline Chihoski** a line for the fine job they did as co-secretaries. Your new co-secretaries will try their best to keep up the good work with your assistance.—**George H. Brattin,** Co-Secretary, 39 Bartlet St., Andover, MA 01810, (617) 470-2730; **Irwin C. Gross,** Co-Secretary, 29 Barchester Way, Westfield, NJ 07090, (201) 233-0424 (H); (212)512-3181 (B)

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Once again, I note the incongruity of watching summer end and writing these notes to wish you Merry Christmas and Happy New Year.

Those of you who are involved with the United States automotive industry in some way may have already heard the news that **Ken Whipple** has been appointed chairman and chief executive of Ford of Europe Inc. His previous assignment was as vice-president, corporate strategy and analysis at Ford. . . . Within the M.I.T. administration, **Glenn Strehle** has become vice-president and treasurer and assumed the responsibility for resource development activities. As part of his new responsibilities, Glenn will direct the M.I.T. development program, including the Industrial Liaison Program and the various offices associated with Institute-wide resource development. He will also coordinate fund-raising activities with the Corporation and its committees. . . . Among the individuals recently named to the position of fellow of the IEEE was **Bruce Wedlock**. As director of the Lowell Institute School, Bruce was cited for his contributions and leadership in electrical engineering education. While on the M.I.T. faculty from 1962 until 1971, he was involved in investigations of the physical electronics of field-effect transistors and other solid state devices. He has co-authored two electrical engineering textbooks and serves as a consultant to several companies in the greater Boston area. . . . **Ahren Sadoff** is involved with the high energy physics collaboration known as CLEO at the Cornell Electron Storage Ring. His recent professional activities have included attending an international conference on Lepton and photons in Kyoto, Japan, as well as presenting a talk on b-quark physics at an international meeting in Spain.

On a recent flight from Boston to Hartford, I ran into none other than **Arnie Amstutz**, who has recently joined Advest, Inc. as executive vice-president. During the brief flight, Arnie expounded on the joys of suburban Connecticut liv-

ing, but yours truly remains a confirmed urban dweller. Since this is the year of 50th birthday parties for most of us, be sure to mark the occasion by sending news of the birthday bash and your latest activities. See you next year.—**Michael E. Brose**, Secretary, 534 East Broadway, South Boston, MA 02127

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Well, at least a few of you heed our pleas for notes. Let's start off with a nice one from **John Chang**. He writes that after finishing up at M.I.T. with the rest of us, he completed an M.S. in systems engineering at Case Western Reserve and then a Ph.D. at the University of Delaware. Five years at Bethlehem Steel followed and then more than 17 years at The Foxboro Co., where he is now a principal consultant. In his work, which takes him all over the world, John provides to processing industries consulting services aimed at improving plant profitability through better process controls and manufacturing strategies. John and wife, Nellie, have two children, son Andrew, 13, and a daughter, age 9. They live in Sherborn, Mass. . . . **Robert Poluthcko** writes from Potomac, Md., that he's still with Martin Marietta Corp. Actually, he's president of the Information and Communications Systems Co.

Some other professional notes. In May, **Donald Parrish** was elected senior vice-president, mortgage and real estate, for East River Savings Bank. Don will be responsible for the origination and underwriting of income-property loans. He lives in Croton-on-Hudson with his wife and three children. Professor **Jan A. Northby**, a low temperature physicist at the University of Rhode Island, has been awarded a Fulbright grant to conduct cluster beam and low temperature research in Gottingen, West Germany during 1986-87. . . . And Northrop reports that **Kent Kresa**, formerly head of the company's Research and Technology Center and general manager of its Ventura Division, was named senior vice-president of technology development and planning. University of Massachusetts Professor **Richard Giglio** presented a short course on manufacturing economic analysis in a recent special satellite broadcast for the National Technological University. He has conducted a number of large scale investment planning studies to determine sizing, location and timing of new plants, as well as major equipment purchases.

Finally a couple of items about my sometimes co-secretaries. The engineering library here at Cornell tells me that they have ordered the new *Mechanical Engineer's Handbook*, edited by none other than **Myer Kutz**. I'm told also that this really is the "bible" for ME's, and I know that Myer has been working on it for a long time. Congratulations! A Book-of-the-Month alternate maybe? Also, **Art Collias** writes that his company, MITEK Surgical Products, has relocated their corporate offices to Dedham, near his home in Canton, Mass. And what did they talk about over the wine and hors d'oeuvres at the grand opening? Probably the fact that their first product, a needle/wire localiser used in mammography, has captured over 20 percent market share in the first six months of distribution. M.I.T. Enterprise Forum, are you listening?

Well, we're headed into the holidays again. So, from the Stones in Ithaca to all of you, please enjoy a happy and peaceful holiday season. And those of you who send out holiday letters, why not send a copy to Art Collias or me? We promise to use only the parts you highlight and believe me, it will make for much more interesting TR reading in the new year.

The editors apologize for assigning a mythical Bob Buh the role of managing director of Bear Stearns' office in San Francisco, in our August/September issue. The correct name is, of course, **Bob Muh**, president of '59.—**Ron Stone**, Secretary, 116 Highgate Place, Ithaca, NY 14850, (607) 257-2249

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One piece of fall-out from the reunion has been a small outpouring of news from classmates. I thank you and hope this bodes well for the future.

Leo Heiblinger writes that "after three years of living in Japan, where I worked for Sanovik KK as Far East engineering manager, I and my wife, Uyeh Hui Heiblinger, moved to Seoul two years ago. In Korea I work as division manager of Sanovik/Korea and my contract here has two more years to go. I would like to hear about other M.I.T. alumni, class of '61 (or others), active in expatriate positions in the Far East, especially in Korea." What a fantastic life Leo has led. . . . **Rod Hanneman** wrote to say he is vice-president and chief technical officer of Reynolds Metals in Richmond, Va. Just the other day he became the Chairman of the Gas Research Institute's Research Coordination Council. . . . **Virgil Vickers** wrote that he is proud of being the father of a flourishing ten-year old girl. . . . **Seth Goldstein** says he is "the head of a team of mechanical engineers doing instrumentation and theoretical studies in the biomedical engineering and instrumentation branch of the NIH. I would rather be backpacking and fly fishing in Montana a lot more often than the one week per year I get."

Old pal **Bob Creasey** says "all is well at the IBM Scientific Center in Palo Alto." The Creasey's daughter graduated from San Diego State and their son got married in San Jose the week of our reunion. Bob thinks this is an adequate excuse for not showing up in Cambridge. His wife, Rosealind, is working on her third Sierra Club book. . . . **Wesley Hilton** works at XSCRIBE which is a "legal automation" firm (whatever that is). . . . **Lloyd Fisher** writes that he is a professor of biostatistics at the University of Washington where he has been directing a huge ($25 million) study on the efficacy of coronary artery surgery. . . . **Dave Sachs** writes: "I am currently directing several projects concerned with developing specialty rubber products for noise control applications on submarines. I have been with my present employer, BBN, in Cambridge since 1973 as a senior scientist. I am also helping to raise two delightful sons, ages 9 and 11. After work my interests include jogging (two miles per day), Cub Scouts and reading the Dune SciFi book series.". . . **Don Fowles** is the editor of the *Journal of Abnormal Psychology*, which sounds very interesting, and professor of psychology at the University of Iowa, which might be interesting.

It's very sad to report another death in the class. **Sanford Weiner** died of cancer in June. Sanford was a high official at Proctor and Gamble in Cincinnati, where he had worked since leaving M.I.T. He also played a prominent role in Cincinnati civic affairs having been a trustee of the Cincinnati Symphony and the Jewish Hospital of Cincinnati. The class sends its deepest sympathies to his wife, Judith, and children.

Bob Andrews, who works for Dow (and has since 1967), is now director of government and public affairs for the Chemicals and Metals Department. This comes after a career which included stops in Brazil and other points in Latin America. Congratulations, Bob. . . . **John Savage**, who is chairman of the Department of Computer Science at Brown University, is an author of a new book called *The Mystical Machine: Issues and Ideas in Computing*. His coauthors were two Brown undergraduates. It is a textbook which covers artificial intelligence, computer architecture, automation and other introductory topics. . . . **John Deutch**, our class provost, picked up another honorary degree last June. This one was from the University of Lowell and was in Humane Letters. . . . New Hampshire governor **John Sununu** has had to juggle his support for nuclear power with his antogonism toward a nuclear dump in New Hampshire in the last couple of months. It has been a success: the Seabrook plant will go into low power production this fall and the dump goes elsewhere. John is a very good politician: doing what is possible.

Next month I will start a series of reports on the outcome of our class questionnaire. I hope you all have a fine Christmas and Hannuka and stay sober over the New Years holidays. You will resolve to tell us what you are doing and what you are thinking about.—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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Summer (yes, chillun, I'm writing this snow-covered column in the s-u-m-m-e-r) has as usual brought postal doldrums to match the gravity of the weather. In other words, there ain't much mail to pass on. From **Mike Maul** I have word he is still working for AT&T's Bell Labs in Murray Hill, N.J., and Allentown, Penn., doing integrated circuits. His wife June (nee Paradisi, class of '67) is also with AT&T in N.J. They have "two Arab horses, four dogs and a six-acre farm."

MacKenzie Hamilton was reported in the *Wall Street Journal* to have been promoted from senior vice-president to vice-president engineering at AiResearch Manfuacturing Co. I have no further details, and would appreciate hearing them from Mr. Hamilton.

I have a copy of an article from the *Kansas City Times* published back in April. It mentions **Steve Ditmeyer**, described as top researcher for Burlington Northern Railroad. Steve is quoted as saying that deregulation pushed the railroad industry into cost-cutting, looking at modern technology, and improving efficiency. Among the high-tech additions to Burlington's operation is an experimental system of locating locomotives by reference to the U.S. government's Navstar satellites.

I have been wondering: with our 25th reunion less than two years away, do any of you have any ideas on how to celebrate? For instance, should we stay with the traditional Massachusetts location, or hold it in a more central location? Are there enough Californians to warrant this? Should it be a weekend get-together, or something lengthier? How formal? I would be pleased to publish comments you want made public. Or address yourself to the class president, **Jack Lynch**, c/o EECS Dept., Northeastern University, 110 Cummington St., Boston, MA 02215.

Some months ago I announced the passing of classmate **Bill Lord**. I have received a note from Jerry Weingart, '61, who knew Bill from Baker House Days, and who was sad to hear of Bill's passing. Jerry asks anyone who knows of the circumstances of Bill's passing to write him at Suite 418, 2000 Center St., Berkeley, CA 94704.

Well, that's all I have from here. Keep the snow out of your boots. Write. Or phone.—**Phil Marcus**, Secretary, 2617 Guilford Ave., Baltimore, MD 21218, (301) 889-3890

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Regretfully, we again start the column on a sad note. From the Alumni Association comes news that **Richard Murray** passed away on January 26 of this year. At the time of his death, he was a resident of Somerville. Richard is survived by a daughter, Linda. No other details are available.

The *IEEE Reflector*, published by the IEEE Boston Section, made mention of a presentation given by **Barry Blesser** on the subject of ultra-quality in audio conversion. After graduation, Barry stayed on at M.I.T. to receive a Course VI Ph.D. He joined the faculty and remained until 1978, attaining the rank of associate professor. Barry is the inventor of the world's first commercial reverberation system. He founded Blesser Associates which specializes in electronic system design.

A brief Alumni fund note came from **David Slosberg**. He is still in Paris with Bull and is loving it. He's trying to arrange a visit to and/or job in Africa. "See you in the States or here

(21, rue des Fougeres, Paris XXe) one of these days,"writes David.

A longer letter came from **Carl Uhrmacher**, our Class President. Carl had called me to assist in identifying Boston area volunteers to help with our 25th reunion. The call reminded him to finish up a letter with news of his activities. Direct quotes follow:

"I married Barbara Pollack, '66, in late August of 1964. After graduation I went to grad school in chemical engineering, graduating in 1967 with a Ch.E. degree. We live in Columbia, Maryland, where we have lived since 1970, with our son, Mark, age 14. We are active in local civic affairs, Carl serving as president of the Howard County Chapter of the Maryland Society of Professional Engineers; Barbara, currently playing a major role in organizing the M.I.T. Club of Columbia. We are also active in the M.I.T. Enterprise Forum of Baltimore-Washington.

"Since graduation, I have worked for Esso Research & Engineering, FMC Corp., and JRB Associates (now SAIC) prior to founding CARLTECH ASSOCIATES, INC. Since graduation, Barbara has worked for IBM, Schering Corporation, and Westinghouse. CARLTECH was founded in 1980 with one employee (guess who); Barbara joined the staff as senior engineer in 1981, with her first job being to select and purchase the firm's computer. The company is a science and engineering firm specializing in chemistry and its related areas, including biotechnology, chemical engineering, materials engineering, environmental science and engineering, toxicology and hazardous materials. CARLTECH now has about thirty employees—Barbara and I are the principal officers.

"I have a message for the class: Our 25th reunion is coming up soon and our class has a problem. Too many of our active participants have moved away from the Boston area in recent years. We have an urgent need for volunteers who live in the Boston area, to assist in setting the reunion up, including physical arrangements. Anyone interested in participating please call at (301) 997-5155 (daytime) or (301) 730-9152 (evenings)."

To our classmates, a plea: Please follow Carl's lead and send some news of your life. Thanks.—**Joe Kasper**, Secretary, 3502 Idaho Ave., N.W., Washington, DC 20016

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Last month I tried an experiment in sending my column by the magic of the ARPAnet. The wonders of our modern world. . . . **Jim Sprinkle** writes that he had his first article published in a popular magazine (*The MACazine* for March 1986), and besides getting paid for it, the article didn't have anything to do with geology. Jim also expressed an interest in finding the 20th reunion book that was published in 1985. **Dave Manalan**, who ran the reunion, says that anyone who wants a copy of the book should send a check for $20 made payable to the M.I.T. Class of 1965 to him at 7 Kelley Rd., Acton, MA 01720. Dave says that the first ten or so people who write will also receive a copy of the 15th reunion book from 1980. If you sent your money for a book and never received one, send a copy of your cancelled check to Dave and he will send the book by return mail.

Mary Coffey continues to work at Bechtel National Inc. as a senior scientist. She writes that commuting into San Francisco is as bad as in the New York City area. . . . **Frank DeRemer** writes that he founded MetaWare Inc. in 1979; the makers of Professional Pascal (tm) and High C (tm) via their own Translator Writing System (TWS), for six computers and four operating systems. Frank and his wife Lynda have been married for eight years and have a daughter, Charis, 4, and a son, Elliot, 1. Frank writes that God has blessed them mightily.

So much for this month's news. At least writing the column is not a chore, though I suspect you readers might be happy to see a bit more news. If so, drop a line.—**Steve Lipner**, Secretary, 6 Midland Rd., Wellesley, MA 02181

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A news release from Wright State University, in Dayton, Ohio, announces the appointment of **Richard Millman** as dean of the newly formed College of Science and Mathematics. He comes to Wright State from a position as program director of geometric analysis at the National Science Foundation in Washington, D.C.

William Marlow, now living in Bryan, Texas, writes: After 11 years of employment at Brookhaven National Laboratory, I am joining the faculty of Texas A&M University in the Nuclear Engineering Dept. My appointment is the start of a long-range effort to expand into more general "applied science."

After 23 years at M.I.T. **Marvin Sirbu** left last summer for Carnegie Mellon University, where he has a joint appointment in engineering and public policy at the Graduate School of Industrial Administration. Shortly after his arrival in Pittsburgh, he and his wife were blessed with a daughter, Margaret Ann Lazarus Sirbu.

Another news release, this one from Charleswater Products, Inc., of West Newton, Mass., which was founded ten years ago by **George Berbeco**. Charleswater has been acquired by Armstrong World Industries, Inc. We wish George good luck in that endeavor.

And, finally, **Robert Purssell** has been named senior engineer in release engineering and operations at IBM in East Fishkill, N.Y.

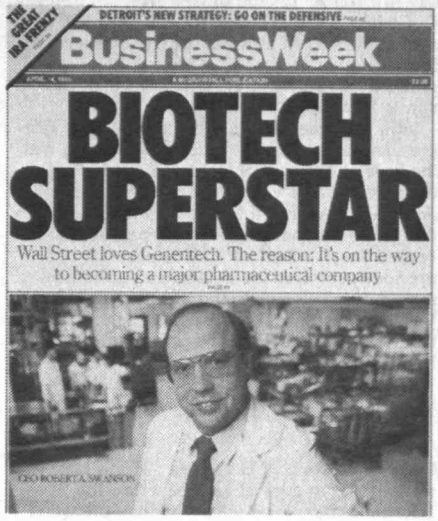
That's the news for this month. Keep those cards and letters coming. The publication delay is about three months, so send it now.—**Jeff Kenton**, Secretary, 7 Hill Top Rd., Weston, MA 02193

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Bill Murray ran the San Francisco Marathon in July and reports that in the process he found something more masochistic that Course 8. . . . **Avram Bar-Cohen** is an executive consultant on Control Data's corporate staff with responsibility for research and engineering in packaging and thermomechanical modeling. . . . **Robert Landley** received his M.B.A. from Rutgers last December, having completed the two-year full-time program on a part-time basis in only two years plus one term. The hectic schedule, together with a 120-mile round trip commute to class, meant that he became a stranger to his family—they are happy about his "return." Bob is still with RCA in Moorestown, N.J. . . . **Ruth McDowell** is a quiltmaker in Winchester, Mass. . . . **Dave Sanders** was recently named general manager of Hewlett-Packard's Office Systems Division in Roseville, Calif., which is near Sacramento. Dave, Jan and family are in the process of relocating there from the San Francisco Bay area. . . . **Richard Simpson** was an associate member of the Voyager Radio Science Team for the Uranus encounter. He worked on the project for several years, and among his pleasant tasks was visiting Australia to collect Voyager II data for processing and evaluation at Stanford University and the Jet Propulsion Laboratory in Pasadena. Dick is a radar astronomer and senior research associate at Stanford. . . . **Erich Hespenheide** can confirm that life comes full circle. Twenty years after he dated Wellesley girls, his daughter Amy enrolled there this fall. Amy received a National Merit Scholarship, and one from Aid Association of Lutherans. She was the highest ranking girl in her graduating class at Arlington High School.—**Jim Swanson**, Secretary, 878 Hoffman Terrace, Los Altos, CA 94022

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Sparce notes for this month folks—count'em one! Dr. **Dinah S. Singer** writes from Maryland: "Al (M.I.T. '68) and I each run independent labs in the Immunology Branch of the National Cancer Institute in Bethesda, Md. We have two sons—Jonas who's nearly four and Eban who's one. Life is busy and fun." Meanwhile back in Fairfax County under the August sun, Gene would like to hear from fellow alumni in the D.C. area who've read *Globe* reporter Susan Traush's book *It Came from the Swamp*. . . . and agree with it.—**Eugene Mallove**, Secretary, 11902 Paradise Lane, Herndon, VA 22071



Robert A. Swanson, '69, chief executive officer of Genentech, Inc., San Francisco, is the "biotech superstar" on the cover of Business Week *for April 14, 1986. "More than any other company," says* Business Week, *"Genentech has come to symbolize the awesome commercial potential of biotechnology. . . .(The company) is sending up rockets on Wall Street."*

M.I.T. recently benefited from Swanson's interest in biotechnology, when he established a professorship fund in the life sciences at his alma mater. Dr. David H. Raulet, the first to hold the Robert A. Swanson Assistant Professorship in the Life Sciences, is recognized for his work in immunology.

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Class ring found: If anyone has a current address for **Gregory Lewis,** please contact Diane Monahan, Alumni Association, M.I.T., Room 12-090, Cambridge, MA 02139, (617) 253-8272.

Arthur E. Perkins, Jr. has moved to Elkhart, Ind., and is the head of the purchasing department of Uniroyal Plastics Co., Inc. He and his Gerri have just become first-time parents. . . . **Ronald Abramson** has moved to the Washington office of the law firm of Fenwick, David & Wert, where he is providing general corporate and securities law services to computer-related clients. . . . **Mark Phelps** is a private practice litigator in patent law. He has a new sailboat moored along the Chicago shoreline. He and his wife Susan and three children are looking forward to many hours

of pleasure on *Concerto*. . . . May 10, 1986 brings some sadness to the Class of 70 in that on that day **Michael A. Pagano** passed away. . . . **Steven C. Carhart** heads up Carhart Associates Inc. in Arlington, Va., an institutional research service focusing upon companies renewing American productive capacity. The name of their publication is *Productivity Investor*.

John M. Gruenstein has become the new vice-president and director of public information with the Federal Reserve Bank of San Francisco. For the previous nine years, he has been a vice-president and director of the regional and urban section of the Economic Research Department of the Federal Reserve Bank of Philadelphia. He had previously received his doctorate in economics from the University of Pennsylvania.—**Robert O. Vegeler**, Secretary, Beers, Mallers, Backs, Salin & Larmore, 2200 Ft. Wayne National Bank Bldg., Fort Wayne, IN 46802

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Laura Middleton, M.D., writes: "When I last wrote, I was in general practice in Mt. Ida, Ark. Two things happened to change that: the worst drought in 30 years (105 degrees all day and no rain all summer) and my 1980 marriage to Ed Nowak whom I met in grad school at the University of Maryland in 1974. Opportunities for theoretical partical physicist like Ed were somewhat limited in Mount Ida (pop. 821) and so we fled the heat north to Provincetown, Mass., where I finished my public health service obligation as medical director of a small clinic. In 1981 Ed started at IBM in Burlington, Vt., and I started a psychiatry residence at University of Vermont. I'm now in private practice and also work part-time with the chronically mentally ill at a community mental health center. Our daughter Rebecca (born June 2, 1986) was long-awaited and is a great joy. Her arrival, however, meant I missed the reunion. I'll continue part-time at work and have come as close as I can imagine to "having it all."

Doron Bardas is manager of integrated systems tests, deputy manager of hardware development, relativity gyroscope experiment, high energy physics lab, Stanford University. . . . **Walter E. Miller** is engineering manager for Northrop Services, Inc. at NASA Ames Research Center. NSI supports the Kuiper Airborne Observatory (KAO) which is a modified C-141A airplane with a 36-inch infrared telescope. The KAO recently spent two months in New Zealand observing Halley's Comet. . . . **Douglas N. Gordon** is married to Caryl Chaiken with two boys: Ben, 11, and Jed, 9, with plans to adopt a Korean girl next year. He is now associate general counsel at Celanese Engineering Resins, a subsidiary of Celanese Corp. ZBT reunion poker game at home of Sam Cohen in Chicago was a great success last fall with players flying in from across the country. . . . **Avi Ornstein** was top fundraiser for the March of Dimes in their local WalkAmerica drive. He completed the 20 km. hike and raised $908. The last weekend in June he hosted the 16th annual gathering of alumni of Alphi Phi Omega from M.I.T. at his family's place in Pennsylvania. Other class alumni present were **Bern (Thor) Krafsig** and **Len Tower**. Avi will be the head of the Science Department at Berlin High School where he has been teaching chemistry for the past six years. —**R. Hal Moorman**, Secretary, P.O. Box 1808, Brenham, TX 77833

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Richard Scordato writes, "I am now vice-president, engineering for Medical Laboratories Automation, a manufacturer of automated blood analysis equipment used in medical labs. My wife, Susan, and I are about to move into a new house with our children, Elizabeth, 4 and Brian, 2."

That's all there is for this month, folks. Make next month fuller. Write now!—**Dick Fletcher**, Secretary, 135 West St., Braintree, MA 02184

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The news is medical and musical this month. **David Moylan** is now director of radiation oncology at the Schuylkill Cancer Center in Pottsville, Pa., as well as assistant professor at Jefferson Medical College in Philadelphia. His wife Denise, a specialist in pulmonary medicine, gave him a daughter, Elizabeth Anne, a year ago July 22. . . . **Steve Altshuler** has begun a psychiatric residency training program at the Mayo Graduate School of Medicine, in Rochester, Minn.

As you may know, the Alexandria (Va.) Harmonizers won the 1986 International Chorus Championship of the barbershop society SPEBSQSA. The contest in Salt Lake City attracted 9,000 fans and regional champion choruses from 16 districts in the U.S. and Canada. Yours truly and 104 others took home gold medals and tons of memories from Utah. A special hi to **Marty Romeo**, a former Harmonizer who left town a few months too soon. Write!—**Robert M.O. Sutton, Sr.**, Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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Congratulations to **Allen C. Hart** who was recently promoted to director, Surveillance Systems Division at Grumman-CTEC in McLean, Va. . . . **Paul Pilorz** is presently with Stern Stewart & Co. in Manhattan as a corporate finance consultant. . . . **J. Stewart Roberts** works as a project manager for Add Inc. Architects and has recently completed a feasibility study/design for renovation of the M.I.T. Student Center. (Can Twenty Chimneys be saved?). . . . The "I miss being a student" award for this month goes to **Robert Gerstmyer** who, after living in Philadelphia, has moved with wife Deb to Durham, N.C. Says Robert, "Deb will begin a fellowship in cardiac anesthesia at Duke. I will be in a Ph.D. program in the Department of Religion at Duke, and doing some work in computer-aided language instruction. A nice side-benefit of the move is that it's now possible to do a lot more bicycling than in Center City Philadelphia."

Joseph Sacco is an assistant professor at Albany Medical College and a proud father, as well. His son Daniel Joseph, born August 13, 1985, is doing great. . . . And congratulations to **Susan Fuhrman** who, as an assistant professor of laboratory medicine and pathology at the University of Minnesota Medical School, has been awarded the Distinguished Teaching Award from the Minnesota Medical Foundation. Way to go, Susie! . . . That's it for 1986. So what's cooking with the rest of you?—**Jennifer Gordon**, Secretary, c/o Pennie & Edmonds, 1155 Avenue of The Americas, New York, NY 10036 or 18 Montgomery Pl., Brooklyn, NY 11215

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Joseph Tavormina now works at Scientific Atlanta in the Instrumentation Division as manager of radar cross section product development. . . . **Jules Morris** has recently been appointed a patent counsel for the U.S. Air Force and is now reviewing inventions arising from government-funded research and aircraft and spacecraft tests.

Bob Struth (lieutenant commander, U.S. Navy) is stationed at the U.S. Navy Postgraduate School in Monterey, Calif. He is pursuing an aeronautical engineering degree to go along with his M.S. in systems management from the University of Southern California. He writes, "I've been in 10 years now, and this is my first non-flying job (I normally fly F-14s). I appreciate the opportunity to expand my education, but I am really ready to get back into the cockpit. Being married with a 3-year-old boy and going to school is certainly different from being a 'devil-may-care' undergraduate. Monterey is very nice, except for the real estate prices. I guess you heard about our neighbor city's new mayor, Clint Eastwood. Maybe he'll do them some good. We recently acquired a white 1955 Thunderbird that we're having loads of fun with. It's in showroom condition, and it's quite a time machine!

"I guess my biggest news is that I was selected to be interviewed by NASA as a mission specialist astronaut. However, the *Challenger* incident has put everything on hold, naturally enough. We will be transferred from here next March. I will be assigned to the F-14 Super Tomcat flight test team at the Grumman Corp., Calverton, Long Island, N.Y. We are looking forward to living on the east coast for a while."

Tenth-year reunion news: your secretary was very sorry to miss it, but some news has come my way. Elections were held, with the following results: president, **Christopher Roberts;** vice-presidents, **Deborah Stein Sharpe** and **Gail Ruben Walker;** secretary, **Arthur J. Carp** (my many thanks); treasurer, **Tom Martin**; executive committee, **Reynold Lewke, Jesley Chernak** (also West Coast agent), **Robert Lepkowski, Gary Duke Spear,** and **James Miller.**

Gary Buchwald is running for the office of town moderator of Sharon, Mass. Gary is running on a platform to reform some of Sharon's quaint, and somewhat archaic, town meeting laws. The incumbent, of course, seeks to maintain the status quo. . . . A note from **Daniel Christman:** "I continue active involvement in music. I am playing for more special programs at churches—14 programs at five churches last Christmas and five programs at three churches for Easter. Because of the growing church involvement, I have cut back on the regular orchestra schedule. I now play regularly with three symphony orchestras, one concert band, and one fife and drum corps. I occasionally play with three other orchestras and two concert bands as the schedule permits."

As for your secretary, he wishes to thank you very much for re-electing him, in absentia. On the business front, your secretary is president of Stalco Futures, Inc., a futures brokerage specializing in institutional futures and futures options hedging for the shipping industry. We cover Baltic freight futures, heating oil/gas oil, foreign exchange, grains, tropicals, and interest rate exposures. This is the other, less understood side of the futures business (vs. speculating), which is not to say that I have stopped speculating in the futures markets—far from it. We have been seeing a wild time in platinum, crude oil, stock index futures, bonds, and foreign exchange. Life is far from dull—some of these markets leave even me white-knuckled at times.

Please write, as we badly need news. I would especially appreciate some details about the reunion activities and attendance.—**Arthur J. Carp,** Secretary, Stalco Futures, Inc., 225 W. 34th St., Suite 1705, New York, NY 10122, (212) 736-2777

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It's not every day that one of our classmates appears in an article in a national news magazine, but there he was in *Time* magazine, sitting in front of an ominous, futuristic looking bank of red lights. It was **Dan Hillis**, designer of The Connection Machine, one of a new generation of computers, using thousands of processors instead of just one. Dan, a co-founder of Thinking Machines Corp. of Cambridge, sees big things for his new machine. *Time* quotes him as saying: "The conventional computer is to the Connection Machine what the bicycle is to a supersonic jet."

Also working on a new generation of computers is **Mark Horowitz**, now an assistant professor at Stanford's center for Integrated Systems. Mark is working on the processor chips for RISC machines (Reduced Instruction Set Computers), which he describes as the "designer jeans" of the

computer industry. The latest design could result in a computer which could perform 100 million instructions per second, making it one of the fastest in the world.

While the rest of us haven't necessarily been getting our pictures in *Time* or *Life* (or even **People**), or designing the world's fastest computers, there is a lot of news. Take **Ed Nadler** and his wife Eileen, who are returning to the states after Ed completed a year post-doc in math at the Technion in Israel. "It is a beautiful country, very rich in many ways, but life can be difficult. For the coming academic year I have a post-doc at IBM Research Center in Yorktown Heights, N.Y." . . . **Nayyar Butt** will also be moving to IBM in Westchester (from Dallas to White Plains) to take on a new position as systems engineering manager. He notes: "I think we will miss Texas."

Academia: After seven years with Chevron Research in Point Richmond, Calif., **Leslie Field** is going back to school at University of California, Berkeley, for an E.E. degree. . . . **Cathy Osman** writes to announce the impending completion of her masters at the Naval Postgraduate School. . . . **Gerard Kriss** is at Johns Hopkins Physics and Astronomy Dept. (he didn't say in what capacity), where he is working on a UV telescope planned for orbit. . . . The 'Tute's Mechanical Department of Engineering just promoted **Anthony Patera** from assistant to an associate professor.

Our final academic entry this month is **Janet Wing**, who is a wealth of news. Janet is on her second year as an assistant professor of computer science at Carnegie Mellon University and writes, "Although Pittsburgh is a livable city, I still miss the energy, pace and culture of bigger ones." Other news: She reports attending a mini-reunion of McCormick Alumnae last Thanksgiving in D.C. Classmates attending were **June Yuson** (from NYC), **Cindy Chen** and her husband David Welch (from Cambridge), and **Cheryl Loui** (nee **Hashimoto**) and her husband Cham. "We met over a sumptious Chinese dim sum brunch; our only regret was not being able to play Charades or Family Feud—there were too many museums to visit." She also reports that **Norman Sheppard** and wife Chris Wang, '77, are living in the Boston area and have a baby girl, Sarah. And, that on a recent consulting trip to Silicon Valley she met **Steve Kirsch** "who is making megabucks as president of Mouse Systems." Thanks for the news Janet.

Thanks to **Julie Kozaczka** for the boring postcards—one of a cactus in Aruba and one of the New England Air Museum. (She writes: "This place is actually more interesting than the postcard." You can imagine my relief.) Jule is working at Mass. General Hospital's Laboratory of Computer Science. "I work for Harvard Medical School's New Pathway project, which is a new, experimental medical school curriculum. My job is about one-half technical writing and one-half user support, except when it isn't. The best part of being here is that almost EVERYONE is a career changer." . . . (Thanks also to Wayne Raila, '79, and Lori Ullman Herman, '81, for boring postcards.)

Jeff Snow where are you???? Ed Nadler (now in Westchester, see above) and **Curtis Scott** (living in Somerville) each wrote to ask where they might find him. Well, guys, bad news; the Alumni Office (Cambridge) lost him. However, **Laura Shultz** (who is just starting her pediatric dentistry practice near Scranton, Pa.) ran into him in an operating room in Cincinnati and reports that Jeff is now in Albany. (No wonder why M.I.T. can't keep up with him.) (Laura also reports meeting **Marc Weiner** in an emergency room at Children's Hospital. "I keep running into people in the strangest places.")

Ralph Lessor wrote to tell us that he just took a job as senior research chemist at the BOC Group Tec. Center in New Providence, N.J., after a two-and-a-half year post-doc at NIH in Bethesda, Md. Before that Ralph did his Ph.D. work in organic chemistry at U. of Illinois at Champaign Urbana. . . . **Ken Lesley** is now living in Monterey, Calif.—on weekends. During the week he lives in Ventura, Calif., where he works for Smith Drilling Systems.

Lawyers: **Ed Golden** seems to be quite the civic leader. In brief, he is vice-president of his law firm, Buck and Golden, member of the county Republican Executive Committee, president of the Christian Lawyers Association, chairman of the board of deacons of his church. He was married in 1979 to the former Jane DeKlavon, and they have two children, Daniel (age 4) and Kimberly (age 1). . . . **Alison Kohler** writes that she is practicing law in Baltimore, specializing in civil litigation.

Kids: **Diana Christman Haynie** writes that she is staying home to care for her three-year-old son. (On the side, she is working as office manager for RESCUE NOW, a non-profit international medical relief organization. She is also a volunteer instructor in CPR and First Aid for Red Cross.) . . . When this note was written, **Dennis McMullen** and his wife Pam were expecting their second child any day. (Their first, Joey, is now over a year.) Dennis just finished his MBA at U. of Cincinati. . . . **Steve Wilkins** and wife Randi dropped us a line about their "beautiful baby daughter Iyla," now almost three.

It may seem like a long time away, but now is probably the time to start preliminary plans for our tenth reunion. I was just talking to **Karyn Altman Velasquez** the other day about it (you may remember that Karyn was the one who did such a great job on our 5th) and we would like to solicit ideas from the class. What would you like to see at our 10th? Send me your ideas—mundane, creative, crazy, absurd or just ludicrous. The best ideas will get used—the worst will be published in this column for the amusement of your classmates. Send your ideas on a boring postcard with some news and kill three birds with one 14-cent stamp.

More news: **Jim Roskind** is in Palm Bay, Fla., working as an independent consultant developing IBM PC software applications. . . . **Bill Kuttner** is now vice-president and analyst at Pioneer Management Corp. in Boston. . . . A note from **Philippe Dordai** announces that he is a registered architect in New York City, working for Guthrey, Siegel & Associates.

That fine journal, the *Hamilton-Wenham Chronicle*, from Ipswich, Mass., reports that **Dave Medeiros** got married this summer at M.I.T. to Lynn Markham, formerly of Hopkins, Minn. Our congratulations. . . . **Mark Bye** recently got promoted to the position of general sales manager of the Performance Chemicals Division of Air Products and Chemicals, Inc. Mark and his wife live in Morristown, N.J. . . . **Peter Cariani** has now finished his Ph.D. at SUNY Binghamton, and is currently working on "models of biological self-organization and structural evolution (with relevance to problems in machine learning)."

A note from **Diane Prignoli** to **Arthur Wendel**: "I was going through the quarter box at a local garage sale when I spotted a nice Air Force charm that claims to be sterling silver—and I thought perhaps Arthur might like this white elephant (golden turkey?)." She adds: "Nothing eventful has happened here in Staten Island, which seems to me pretty good news!"

Class president **Jim Bidigare** has been hard at work on his true avocation—rowing. Jim won a gold medal in a quad shell at the US Rowing Association Regionals in Albany in June. He also rowed in the men's Nationals in Indianapolis. In the meanwhile, Jim's wife and business partner, class agent **Diane Curtis** has been hard hard at work fund-raising. She reports that the class's donations are up over 32 percent over last year, and that the Class of 1978 Student Aid Fund has an endowment of over $72,000. Our first two scholarships were granted this fall. Many thanks to all who attended and helped raise funds.

Not too much news here. Yuko and I spent a few days in San Fran early this summer, where we stayed with **Rich Perlstein**. (Rich is working as an architect in SF and is living in Oakland.) Let me tell you, if you ever really want to see a city, tour it with a local architect. Yuko is just finishing her summer job; I'm still learning the ropes at Boston's University Hospital, and still really enjoying it. So I'll sign off now. Please, send me news, reunion ideas, boring postcards, foreign stamps, samplers, stain glass windows, tattoos, anything. More, more; I'm still not satisfied. WRITE.—**David S. Browne**, Secretary, 50 Follen St., #104, Cambridge, MA 02138, (617) 491-5313

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Lots of news for all you gossip-hungry animals out there.

Two amusing postcards found their way into my mailbox recently. **Jeff Dugal** writes, "I've been bummed the whole time that I've been in Alaska that I forgot your address until I ran into **Mark de Lemos** at Thunderbird Falls, 15 miles north of Anchorage. Mark and I shared a suite in Burton House for two years and, would you believe, had your address with him! The trip has been a great success. My girlfriend Lisa and I camped on Mt. McKinley while in pursuit of a bull moose. We got within 70 feet of him eventually to take his picture. We've also seen bald eagles, grizzley bears, caribou, dall sheep, killer whales, harbor seals, puffins, etc. We even got to kayak on Resurrection Bay. Regards to all." Sure enough, a few days later, I heard from Mark de Lemos: "I'm writing to corroborate that Jeff Dugal and I actually did encounter each other randomly on the trail to Thunderbird Falls near Chugiak, Alaska, earlier this week. I started with your class but graduated a year early. Since 1978 I have spent five years unsuccessfully pursuing a Ph.D. in mathematics, one year programming computers in Edinburgh, Scotland, one year obtaining a teaching credential in high school math which I intend never to use, and one year working in Berkeley for a small company in programming and customer support. Perhaps now I should start dividing my time into three-month increments?!"

Peter Riemenschneider popped up in New York recently. Peter is in the process of moving here from L.A., and spends two weeks in L.A. at his job there, and every third week here looking for a new job. Peter's wife Miranda (Mengis, Wellesley '78) has just gotten her M.B.A. from Cornell University, and is beginning a job with Swiss Bank Corp in New York, so Peter has decided to take this opportunity to switch careers and go into investment banking. Peter and Miranda have been married since December 1979. He has been with Hughes Aircraft in L.A. since July of 1980, currently in the capacity of technical section head. In addition to his full-time job, he has been attending school full-time at U.C.L.A., leading to an M.S.E.E. in 1983 and a Ph.D. this year. (After a schedule like that, the frantic pace of New York should seem downright relaxing!)

Peter was quite forthcoming about his brothers at Phi Beta Epsilon who were in our class. . . . **Richard Allen**, his wife, and two children live in San Diego, where he is a supervisor for General Dynamics. . . . **George Blossom** graduated Harvard Business School this year and will be marrying another M.I.T. grad. He is working in manufacturing for Hewlett-Packard in Maryland. . . . **Rob Currier** is "slaving away on a Ph.D. in chemical engineering" at Tulane University in New Orleans. . . . **John Huber Edmondson** is working in Connecticut on a computer company startup called Canaan Computer Corp., where he is a senior design engineer. . . . **Roger Gettel** is "wheeling and dealing in insurance." He and wife Wendy Barrett (Wellesley '79 or '80) spend their time fixing up the old house in New Hampshire which they recently bought.

More news from Peter: **Scott Holmes** spent four years at Wright Patterson AFB. He is now getting a Ph.D. in nuclear engineering and materials engineering from the University of Wisconsin, where he studies supermagnets at very low tem-

peratures. He is married to a teacher. . . . **Vic Rhoades** is a "slum landlord in Somerville; plans on building the ultimate stereo; and maintains a steady and continuous presence at the PBE frat house at M.I.T.!" Other activities since graduation include courses toward a masters in acoustics at Penn State (abandoned because of bad teachers), running a family-owned foundry in Pennsylvania, and working for Exxon. . . . **Roy Russell** worked at M.I.T. for Lou Braida in electrical engineering, and is now with Kurzweil, trying to build a voice-activated typewriter. He and wife Robin Chase (Wellesley '80) bought a house "with no plumbing" three years ago on Green St. in Cambridge (near the Orson Welles Theatre). Peter reports that the house is "making steady progress." Roy and Robin recently went on a safari in Kenya. . . . That's all on PBE. Thanks, Peter, for spilling the beans!

Don Richards got his M.B.A. last year from the University of Chicago, and went to work for Bankers Trust. He recently joined Salomon Brothers as an associate in their New York office. . . . **Joel West** writes that he "left CACI to, as they say, pursue other business interests, and found that being self-employed means a crash course in spreadsheets and balance sheets. In the meantime, I've been trying to combine my most recent careers—computers and journalism—by writing for *Byte* and *MacTutor*." . . . **Paul Hoffman** writes, "I now have five books (all on computers, unfortunately), and am in process on three more. Are there any other alumni in publishing? I also write freelance and edit for many companies. The political science degree may become useful soon!"

Jim Walker writes, "I have been working as an actor in the Boston area for four or five years, having done some commercial and TV work as well. I do a lot of work at the Lyric Stage Co. in Boston; keep your eyes open. I work in Maine during the summer and will be travelling to Baltimore in the fall of '86 for a show." . . . **Paul Finman** says, "The beginning of this year I started work at Eaton IMSD in Westlake Village, Calif. The job is very interesting and challenging work in microwave engineering, and I enjoy it very much."

Tim Bliamptis has joined the M.I.T. Treasurer's office as assistant to the treasurer. Tim got an M.B.A. from the Wharton School in 1985 and was a managing consultant at the school's Small Business Development Center. He has also been a business consultant and worked in a technical position at the Draper Lab. . . . **Thomas Theurkauf** is a vice-president in Connecticut National Bank's Specialized Industries Division. Thomas is a director in the Investment Banking Department and is responsible for providing merger and acquisition, valuation, and financial advisory services to middle market corporations in the New England area. He joined the bank in 1981 as a planning analyst and later became a corporate finance officer in the Financial Division. Thomas got an M.B.A. from the Amos Tuck Business School at Dartmouth in 1981.

That's all the news for now. Write soon.—**Sharon Lowenheim**, Secretary, 303 E. 83 St., Apt. 24F, New York, NY 10028

81

Hello everybody! I hope that this column finds everybody well and enjoying themselves. Before we get into the class news, I'd like to pass along the results of the 5th Reunion Gift Program. **Jeff Solof** and **Marc Chelemer** did a great job chairing the effort along with members of the committee: **Mitchell Brook**, **Jonathan Danner**, **George Dowd**, **Debbie Foutch**, **Anthony Gerst**, **Jorge Herrera**, **Phil Hood**, **John Hou**, **George Lesieutre**, **Barbara Messinger-Rapport**, **Cynthia Zannetos Peltier**, **Colin Shepherd** and **Rob Steinberg**. Here are the results: 51 percent of us made gifts between July 1985 and June 1986, 62 gifts were for $100 or more, $9,604 was raised toward the $50,000 endowment of the Class of 1981 Student Aid Fund. Members of the class of 1981 donated a total of $29,409 to M.I.T. during the 1985-1986 Fund year. We thank you all for a job well done!

Now, on to the news! **Amy Luttinger** wrote to say that she will be starting graduate school next fall. She reports that she is interested in the molecular biology of infectious diseases. Amy also claims that New Jersey isn't quite as bad as she thought. . . . **Kathryn Gropp** is sorry that she was not able to attend the reunion in June. However, she did celebrate by graduating from the College of Veterinary Medicine at the University of Florida. Now she is off to the University of Pennsylvania's Large Animal Clinic to start an internship in equine medicine and surgery. . . . **Lynn Cominsky** has left the EUVE satellite project at UC Berkeley Space Science Lab to become associate professor of physics and astronomy at Sonoma State University in Bohnert Park, Calif. . . . **Tom DeBoissiere** was married to Janette Marie Earl on June 14th in Laurel, Md. Please send us more details!

I ran into **Eddie Marcus** on the esplanade (banks of the Charles River) a couple of weeks ago. He's doing well and is moving back to the Boston area. I am enjoying the last weeks of summer here in Boston and am looking forward to your letters. Please write!—**Lynn Radlauer Lubell**, Secretary, 216 Beacon St., Boston, MA 02116

84

Mona Wan and friends finally got recent alumni together. They organized a great picnic at Half Moon Bay and had a record turnout. **Nancy Beckman** was there and she apologized for not answering my last phone call. She's been busy working alot of overtime at IBM and spending her free time on her one-sixth of a Hobiecat. Nancy came with **Betty Beitz**, who also works at IBM, and **Tom Ransahof**. Some people I didn't even know were in the Bay area are **Eve Riskin**, who's getting her Ph.D. at Stanford in E.E. and **Steve Knapp**, who left Sacramento and is working in Silicon Valley when he's not traveling on the job.

At another M.I.T. function, I ran into **Ed Kozinski**, who told me the scoop on all his fraternity brothers at TEP. Unfortunately it's been a while and I've forgotten it. I seem to remember that he said **Charlie Oppenheimer** is back at M.I.T. for an advanced degree. **Suzanne Greene** was at the lecture too. She is working at IBM and doing well. **Cathy Naylor** visited me on her way back from Japan, where she had been teaching a class for Digital Equipment Co. She loves living in Boston and working at DEC. While Diana Tener, '86, and Robin Scott, '86, were visiting me, Susan (Flynn) Izatt, '83, and **Joe Izatt** stopped by for a few days. Sue is in medical school at Tufts and Joe is getting his Ph.D. at M.I.T. in nuclear engineering. . . . Last I heard from **Scott Globus**, he sent a postcard from Oshkosh, Neb., promising to return to San Francisco. . . . **Mike Battat** is working 8 a.m. till 10 p.m. and promises that his professors will flip at the news that he's working so hard. He tells me that **Tim Chambers** and Robin Barker Chambers, '85, have moved into a new home in Colorado Springs, where they're both working for HP.

Liz Bashoff is at medical school at Stonybrook. Last time I saw here was over a year ago in S.F. Hi Liz! **Marcia Simon** wrote me recently. She's starting grad school at Cornell. She was excited to find that a library in D.C. has all the Brady Bunch episodes. . . . **Dennis Clarke** is living in Hackensack, N.J. in his den of mirrors. He says the mirrors were there when he moved in, but we're all skeptical. . . . **Stella Hetelekidis** is at medical school in Rochester. . . . **Anita Wahi**, **Wayne Sossin**, and **Dave Short**, are all working hard on their Ph.D.s at Stanford.

I love S.F. and my job at PG&E. I've been spending some weekends camping and hiking in the mountains exploring northern California. P.S. **Nancy Beckman** would like me to apologize for her for all the letters she hasn't answered. She promises to write soon from a new address.—**Lisa Tener**, Treasurer, 205 7th Ave., #3, San Francisco, CA 94118

85

Hello! My mailbox was not very full. I'll assume you've all had a busy summer. Our illustrious president, **Inge Gedo** is now in West Germany where she is serving in the Electronic Security Group. She recently completed the Basic Signals Intelligence course. . . . **Diana ben-Aaron** is continuing a successful career in journalism—she is an associate editor for *InformationWEEK* which is a journal of the information systems industry. . . . **Edith Want** is enrolled in the doctorate program in molecular biology at Columbia.

Jeff Winner and I recently joined Dennis Sacha, '84, and Neil Savasta, '84, for drinks when Dennis was in town (he's at the Naval Pilot Flight School in Texas). Dennis told me that he and some others helped write a column for Peter Tu, so I git thinkin'. . . maybe this can work for me! So if anyone would like to write a column just let me know or send to me!

Danny Orange dropped me a note regarding his adventures since graduation. His travels took him to "Mexico . . . by ship to Tahiti, Figi (his favorite), by yacht to New Zealand where he backpacked and hitchhiked, Australia where he saw Sydney and Perth with a pitstop in Tasmania (he was thrown out of the Royal Perth Yacht Club), Indonesia—the beaches of Bali, markets of Java, and jungle of Sumatra; Malaysia, Thailand—beach-bumming and the golden triangle trek; Burma and the ruined city of Pagan, one night in Bangkok and the shopping Mecca of Hong Kong. He met up with Bob Newman, '88, and they continued to mainland China to have a wild time at Chinese New Year . . . then on to Tibet (thin air, cold weather, amazing mountains, and Yaks). From Tibet they travelled overland to Katmandu, Nepal, then to London, Paris, Milan, Florence, Venice, Munich, Amsterdam, and M.I.T." of course (no doubt saving the best for last . . . eh Danny?). He is now at UC, Santa Cruz working towards a Ph.D. in geology. Has anyone else been on "vacation" recently?—**Stephanie Scheidler**, Secretary, 3511 Shafer Dr., Santa Clara, CA 95051, (408) 985-6651

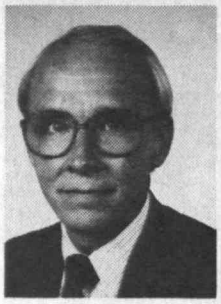
86

Greetings from the thriving metropolis of Dale City, Va. This one's going to be short and sweet. Two of our classmates are still abroad: **Vivienne Lee** spent some time in Taiwan and **Fred Johnsson** was touring Amsterdam. That's about it from the Old Country.

I talked to **Brian Miller**, our member at large, and he's finally found an apartment in Boston. **Chris DaCunha** and **Rich Maurer** are his roomies—this should prove to be quite an interesting arrangement. I was recently in Boston; actually, on the Cape. **Karen Wohl**'s family had a house in Chatham so I came to visit. We stopped by Dennis to see Catherine Cherubino, '88, who's spending the summer lifeguarding there. I also ran into **Anthony Scotti**; along with Karen, we road-tripped to Philip's Academy in Andover, Mass., to visit **Ellen Epstein**. She was just finishing up her summer there as a teacher for the high school program. She'll be returning to Boston at the end of August.

Well, gang, that's about it. Oh, I almost forgot. I ran into **Pat Moran** at DejaVu, a club in Springfield, Va. He's repaying his obligation to the armed forces (sound familiar?) at Fort Belvoir, Va.

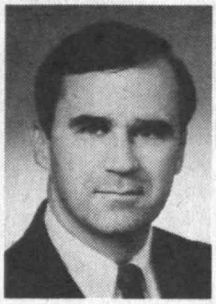
Sorry this is so brief, but I can't write about what I don't know. So, pull out those Crayolas and drop me a line. Also keep those regional parties in mind. They'll be coming up in June.—**Mary E. Cox**, Secretary, 14317 N. Brook Dr., Dale City, VA 22193



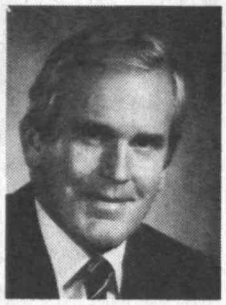
J. B. York



D. S. Chan



W. L. Benham



W. G. Kay, Jr.

I CIVIL ENGINEERING

Franklin G. Ching, Ph.D.'84, vice-president of H.W. Moore Associates, has been elected vice-president of the Metropolitan Area Planning Council (MAPC), Boston, a regional planning agency serving 100 towns in the Boston area. Ching formerly served as MAPC's treasurer. . . . **Egor P. Popov,** S.M.'34, a faculty member (since 1946) in the Department of Civil Engineering at the University of Berkeley and professor emeritus (since 1983) has been elected an honorary member of the American Society of Civil Engineers. Popov was recognized "for his activities in teaching, research, and practice over a period of four decades." . . . **Jerome B. York,** S.M.'61, has changed positions at Chrysler Motors, Detroit: from vice-president of advance manufacturing operations to vice-president of truck operations.

II MECHANICAL ENGINEERING

A new job for **Robert W. Mann,** '50, Whitaker Professor in Biomedical Engineering: in addition to his teaching, Mann is directing bioengineering programs in the Whitaker College of Health Sciences, Technology, and Management at M.I.T.

Robert W. Poole, Jr., '66, president of the Reason Foundation and editor of its magazine, *Reason*, is editor of *Unnatural Monopolies: The Case for Deregulating Public Utilities* (Lexington, Mass.: D.C. Heath and Co., 1986). The argument is that anti-trust law is evolving in ways that permit long-term private contracts to substitute for public monopolies. Among the contributors: **Charles Jackson,** Ph.D.'77, principal in Shooshan and Jackson, Inc., Washington, D.C., and the late **Ithiel D. Poole,** professor of political science at M.I.T.

Jan Gatowski, Sc.D.'85, has been appointed to the faculty of the Lawrence Institute of Technology's School of Engineering, Southfield, Mich. Gatowski will continue serving at General Motors Research Laboratories. . . . **Michael Yovanovich,** Sc.D.'67, professor of mechanical engineering and director of the Microelectronics Heat-Transfer Laboratory at the University of Waterloo, Ontario, has been elected to fellow grade of the American Society of Mechanical Engineers. Yovanovich specializes in the development of "theory on thermal-contact resistance and for mathematical techniques applied to heat-conduction problems."

III MATERIALS SCIENCE AND ENGINEERING

William S. Coblenz, Ph.D.'81, has joined the Norton Co., Northboro, Mass., as a key technologist for physical ceramics, assigned to Norton's new high-performance ceramics research and development facility. . . . Three alumni in the department have been named fellows of the American Society for Metals:

☐ **John F. Wallace,** S.M.'53, Republic Steel Professor of Metallurgy, Department of Metallurgy and Material Science at Case Western Reserve University, Cleveland, cited for "major contributions to the technology of cast metals, cast process, and solidification behavior of both ferrous and non-ferrous metals."

☐ **Arthur H. Aronson,** '58, president and chief operating officer of Lukens Steel Co. and senior vice-president of Lukens, Inc., recognized "for applying metallurgical principles and managerial techniques with diligence and sensitivity resulting in . . . rewarding enterprises in the specialty steel business."

☐ **Joseph Irwin Goldstein,** Sc.D.'64, vice-president of research and professor in the Department of Materials Science and Engineering at Lehigh University, Bethlehem, Pa., cited "for pioneering research on diffusion controlled reactions in iron base alloys and metallic coatings . . ."

Manohar Singh Grewal, Sc.D.'72, group manager of research for the Gillette Co., South Boston, has been elected president of the World Sikh Organization, U.S.A. Grewal's goal as president is to "protect and promote Sikh interests and to work toward bringing unity among the Sikhs" in India and this country, he said. . . . **Luis Soto,** S.M.'80, of New York City, passed away on May 7, 1986; no further details are available.

IV ARCHITECTURE

Mark M. Jarzombek, Ph.D.'86, is in residence for the 1986-87 academic year at the Getty Center for the History of Art and the Humanities, Santa Monica, Calif., preparing his dissertation, "Leon Baptista Alberti: The Philosophy of Cultural Criticism," for publication. . . . **Christos Spanoudis,** M.Arch.'70, writes that he is chief technical advisor with the United Nations Center for Human Settlements (Habitat) in Qatar. His address: c/o U.N.D.P., P.O.B. 3233, Doha, Qatar, Arab Gulf.

Merlin E. Lickhalter, '57, is senior vice-president and managing director of Stone, Marraccini and Patterson (SMP), St. Louis. Following the merger into the firm of Smith and Enzeroth, Inc., SMP is one of the largest architectural and planning firms in St. Louis. Lickhalter has been in the architectural and planning fields for over 27 years, serving as principal for projects totaling nearly $500 million. Some of the projects: St. Louis University Hospitals, Mallinckrodt, Inc. Laboratories, Argyle, N.Y.; Citicorp renovations, St. Louis; and the Clinical Research Center, Chengmei, Thailand.

V CHEMISTRY

Two members of the M.I.T. community are participants in the 30th Welch Foundation Conference on Chemical Research in Houston in November: **J. Ross Macdonald,** S.M.'47, retired vice-president for corporate research and development at Texas Instruments, and **Mark S. Wrighton,** Frederick G. Keyes Professor of Chemistry at M.I.T., are principals in the three-day program on "Advances in Electrochemistry."

John Deutch, Ph.D.'66, M.I.T. provost, member of the Corporation of Draper Laboratory, and Trustee of the University Research Association, has been elected to the Wellesley College Board of Trustees for a six-year term, effective last July. . . . **David L. Morse,** Ph.D.'76, has been appointed manager of optical components research in the Research and Development Division at Corning Glass Works, Corning, N.Y. Morse joined Corning in 1976; his most recent position was senior research associate.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Major honors have come to two graduate students at M.I.T.: to **Carey M. Rappaport,** '82, the 1986 H. A. Wheeler Prize of the IEEE Antennas and Propagation Society for the best applications paper of 1985; and to **Seng-Tiong Ho,** '84, a $12,000 Newport Research Award from the Newport Corp. of California and the Optical Society of America for outstanding research in laser and electro-optics technology. Rappaport won four degrees in 1982, six years after entering M.I.T.—S.B.s in mathematics and electrical engineering, an S.M. in electrical engineering, and an E.E. Ho holds three degrees, all given in 1984—S.B.s in physics and electrical engineering and an S.M. in electrical engineering.

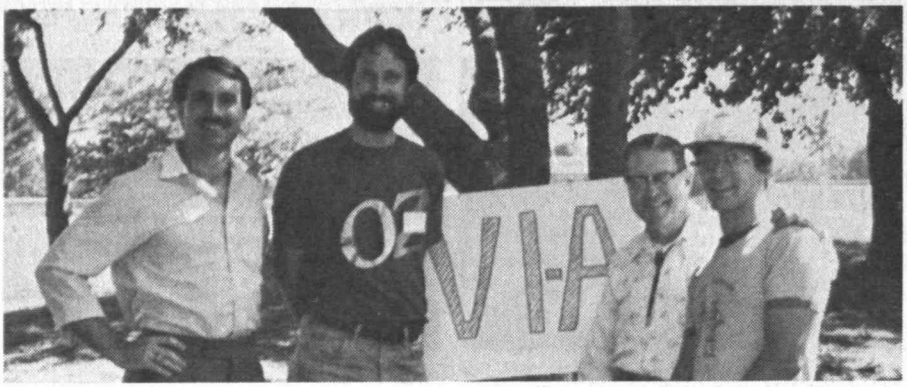
William H. Ware, S.M.'42, senior member of the research staff of the Rand Corp., Santa Monica, Calif., received the 1986 Distinguished Service Award of the American Federation of Information Processing Societies (AFIPS). Ware served as the first president of AFIPS and has chaired several committees such as the Special Committee on Privacy. . . . **Paul Demko, Jr.,** Ph.D.'66, is consulting engineer of Wang Laboratories, Inc., Lowell, Mass.

J. Eldon Steelman, S.M.'62, professor in the Department of Electrical and Computer Engineering at New Mexico State University, Las Cruces, was selected as an outstanding IEEE advisor in the region. . . . **David S.K. Chan,** Ph.D.'71, has left ARCO Oil and Gas Co. as senior engineer to join the General Electric Research and Development Center, Schenectady, N.Y., as an electrical engineer. . . . Two alumni have been named fellows of the Optical Society of America:

☐ **Thomas S. Huang,** Sc.D.'63, in the Department of Electrical Engineering at the University of Illinois, Urbana, "in recognition of his contributions to image processing and computer vision."

☐ **Frederick J. Leonberger,** Ph.D.'75, with United Technologies Research Center, East Hartford, Conn., cited "for his pioneering contributions to optoelectronics and integrated optics."

Leonard Kleinrock, Ph.D.'63, professor of the Computer Science Department at the University of California, Los Angeles, was awarded the pres-



VI-A's 8th annual West Coast picnic last August 10, proved to be the most successful ever.

Director John Tucker (center right) poses with planning committee members John Chisholm, '75 (left); Kenneth Van Bree, '71; and Michael Crystal, '85 (right). John Jarve, '78, and Alan M. Marcum, '78, also committee members, were not photographed.

tigious Marconi International Fellowship by His Royal Highness Prince Albert in Brussels, Belgium, last July 3. Kleinrock was cited as a "pioneer researcher and teacher in computer networking, including fundamental contributions in creating the first data transmission network linking computers at remote sites."

VI-A Internship Program

VI-A's most successful West Coast picnic was the 8th annual event last August 10 at Mitchell Park, Palo Alto, Calif. Some 66 students, alumni, and guests attended on what was a perfect day, weatherwise. For the second year in a row the major planning for the event was carried out by VI-A alumni members of the M.I.T. Club of Northern California and a VI-A student representative.

A planning dinner Friday evening (August 8) was hosted by Director Tucker. This year's planning committee included: **J. Dana Chisholm,** '75; **Michael R. Crystal,** '86; **John W. Jarve, Jr.,** '78; **Alan M. Marcum,** '78; and **Kenneth A. Van Bree,** '71. Professor **Jonathan Allen,** '68, who was in Palo Alto visiting Hewlett-Packard as part of his VI-A faculty advisor duties, also joined us.

We were pleased that last year's oldest alumni attendee, **Richard T. Perry,** '25, joined us again this year accompanied by his daughter, and **Russell E. Coile,** '38, drove up again from Pacific Grove, Calif. It was wonderful to reminisce with them about VI-A times of the past. Another one of our regular attendees, **Paul E. Stoft,** '49, informed us that he was retiring from his corporate staff position at the Hewlett-Packard Co., effective last October 30. Paul's been co-ordinator for the VI-A Program at H-P since they joined back in 1970 and has been a friend of John Tucker's since John joined M.I.T. in 1956 when Paul was assistant professor here. Ken Van Bree will be taking over Paul's VI-A duties.

Attending from farthest away was probably **Edward C. Giaimo,** '74, who flew down from Seattle, Wash. Ed is with Zetron, Inc., Bellevue. It was also nice to see **Mark T. Fuccio,** '80, again, along with his wife "Jackie." They were married on July 13, 1986, and live in San Jose. Mark is now with Daisy Systems Corp., Mountain View.

Although on the planning committee, both last year and this, John W. Jarve, Jr., was unable to attend this year's festivities because of a more pressing engagement—he was to be married at the time of the picnic.

A fairly complete list of other alumni/ae attendees: **Richard W. Ahrons,** '53; **Peter Bonee,** '79; **Peter E. Braisted,** '80; **Michael Chessman,** '63; **Robert M. Colopy,** '74; **John F. Cooper,** '74 and wife; **John A. Edighoffer,** '73; **Payne Freret, Jr.,** '72; **Steven T. Kirsch,** '78; **Carl W. Linde,** '85; **William T. Maimone,** '84; **Alan M. Marcum,** '78; **John C. Mercier,** '83; **Mark S. Radwin,** '64; **Lynn M. Roylance,** '67; **Eric A. Slutz,** '74 and daughter; **L. Alan Snyder,** '73; and Professor **David F. Tittle, Jr.,** and his wife.

This year, at the suggestion of the Northern California Alumni Club, M.I.T.'s Educational Council invited some 25 Bay Area pre-freshmen to attend our picnic. The thought was this would be a good way for the new students to associate with current students and find out what to expect in the fall. Four of them did join us and we hope the idea will catch on better next year.

Also attending the picnic for the first time was Associate Director **Kevin J. O'Toole,** '57, and his wife. His stop in the Bay Area was part of an extended VI-A trip visiting Tektronix near Portland, Ore., and Rolm Corp., in Santa Clara, Calif.; he went on to Texas Instruments in Dallas for the annual VI-A luncheon hosted by **Cecil Green,** '23, followed by a backtrack to Phoenix. In all, he visited 13 of the VI-A companies this summer.

A nice note came from **Maxwell D. Millard,** '33, from West Falmouth, Mass., saying he regretted he couldn't attend the picnic. Seems he summers on Cape Cod but his home is in Pebble Beach, Calif. He wrote to tell me of his "fond memories of my days in VI-A even though the course was truncated by the depression."

Other news gleaned at the picnic: **Allen J. Baum,** '74, is now with Apple Computer; Alan M. Marcum, is now working at SUN Microsystems, Inc. and was being married the week following the picnic and Ken Van Bree was to be his official photographer.

Sunday evening following the picnic Mike Crystal and John Tucker were invited to a social get-together by Payne Freret and his wife, Lynn Roylance. This was the occasion for owners Payne and John to update their respective backlogs of Mercedes-Benz information.

On Thursday, prior to the picnic, John F. Cooper, took Ed Giaimo and John Tucker on a day's sail around San Francisco Bay aboard his 33-foot cabin sailer *Flying Dutchman*. What a magnificent and different view of the city of San Francisco, Oakland Bay Bridge, and a huge aircraft carrier tied up at the Alameda Naval Air Station. John is with Dolby Laboratories in San Francisco and lives in El Granada, Calif.

While in Palo Alto, Mr. Tucker visited the latest Digital Equipment Corp. facilities to have VI-A students—the Systems Research Center and the Western Research Laboratory. During the visit John met **Michael D. Schroeder,** '73, who had been a VI-A faculty advisor to Xerox PARC during his time at M.I.T., and **Steve E. Jeske,** '69, who was working for the Systems Research Center and remembered John from his early days at M.I.T. as executive officer—Student Affairs.

On August 13 the 14th annual TI VI-A luncheon was hosted by VI-A alumnus Cecil Green, at the Petroleum Club in downtown Dallas. Fortunately, Cecil was able to be with us and was in good spirits in spite of an earlier automobile accident and the serious illness of his wife Ida. He had as his guest Jerry Junkins newly appointed president and chief executive officer of Texas Instruments, Inc. This was the first such luncheon attended by a TI president. Junkins spoke following the luncheon of the virtues of the VI-A Program and how much TI values its participation.

Director Tucker used the occasion to present Mr. Green with a matted hand-colored sketch of M.I.T.'s McDermott Court and the Green Building as an expression of thanks for his many years of supporting VI-A at TI. At the end of the program, Mr. Tucker told the assemblage of Cecil's recent award of an honorary doctorate from Oxford University. The tradition of having all VI-A students give short talks was continued and Berryman and O'Toole were also invited to speak.

Continuing a custom started some years ago, TI's George L. Berryman, and wife JoAnn, hosted John Tucker at their lovely Dallas suburban home during his stay.

As noted above, a former VI-A now on his Ph.D. program at M.I.T., **Carey M. Rappaport,** '80, is the 1986 recipient of the H. A. Wheeler Prize from the IEEE's Antennas and Propagation Society. . . . For the 1986 fall term **Michael J. Marcus,** '68, has returned to the campus as a visiting professor to teach a graduate subject in "Telecommunications Policy." Mike is chief, Technical Analysis Division, Office of Science and Technology, Federal Communications Commission.

In July **Joseph M. Aein,** '57, of the Rand Corp. visited the VI-A Office with a representative of Intelsat who was inquiring about their joining the VI-A Program.

Finally, an update of those not already mentioned who have come by the VI-A Office and signed our *Guest Book* since our last writing: **John R. English,** '83, living in Framingham, Mass.; **Leonard N. Evenchik,** '77, director of strategic planning for Tekelec TA, Inc., Bedford, Mass.; **Andrew M. Hawryluk,** '77, Lawrence Livermore Labs., Calif.; **Oscar P. Manley,** '56, U.S. Department of Energy, Washington; **Daniel Naor,** '80, elop-Electrooptics Industries, Inc., Rohovot, Israel, on his way thorough on a business trip; **Andrew L. Robinson,** '79, assistant professor at the University of Michigan, Ann Arbor; and **Newland F. Smith, Jr.,** '33, of Heath, Mass., now retired.—John A. Tucker, Director, VI-A Internship Program, M.I.T., Room 38-473, Cambridge, MA 0213

VII BIOLOGY

Professor **Philip Allen Sharp** in the department at M.I.T. was one of three scientists to receive a 1986 General Motors Research Foundation Prize. The $100,000 prize and additional $30,000 with which to organize a conference in his field came to Sharp for his leadership in "research that produced one of the greatest surprises in biology in more than 30 years . . . leading to a new field of research in the chemistry of genetics." . . . **David C. Page,** a Whitehead Institute Fellow, is one of the latest recipients of the no-strings-attached awards from the MacArthur Foundation. Page's work focuses on the biological factors which determine maleness. Through studying the Y chromosome Page has identified and now hopes to isolate a tiny piece of DNA that is a prime candidate for determining male characteristics in the fetus.

PHOTO: J.A. TUCKER

VIII PHYSICS

Henry H. Kolm, Ph.D.'55, was the guest of honor early this fall at the First U.S. Maglev Transportation Conference and First Lunar Development Symposium, held together in Atlantic City, N.J., under sponsorship of the Engineers' Club of Philadelphia. After a long association with the Francis Bitter National Magnet Laboratory at M.I.T., Kolm has formed EML Research, Inc., Cambridge, to pursue applications of high-energy magnetic fields.

Lawrence J. Varnerin, Jr., Ph.D.'49, has been appointed chairman of the Computer Science and Electrical Engineering Department and the Chandler-Weaver Professor at Lehigh University, Bethlehem, Penn. Varnerin was formerly head of the Heterojunction Integrated Circuit and Materials Department at AT&T Bell Laboratories, Murray Hill, N.J. . . . **Ralph M. Moon,** Ph.D.'63, formerly leader of the Neutron Diffraction Group at the Oak Ridge National Laboratory, has been appointed a section head in the Solid State Division, responsible for the ORNL Neutron Scattering Facility and the National Center for Small-Angle Scattering Research.

The following alumni have been elected fellows to the American Physical Society: **Marc Davis,** '69; **William Douglas Watson,** Ph.D.'64; **Frank Lee Galeener,** S.M.'58; **Richard McFadden Martin,** '64; **Verne L. Jacobs,** '64; **Paul F. Liao,** '66; **Franz Lucretius Gross,** Ph.D.'64; **Elliott Daniel Bloom,** Ph.D.'70; **Henry W. Kendall,** Ph.D.'55; **Robert Daniel Tripp,** '49; **Robert Lee McCrory,** '68; and **David Orvin Overskei,** Ph.D.'76.

X CHEMICAL ENGINEERING

Eight members of the M.I.T. community are to be honored during the 1986 annual meeting of the American Institute of Chemical Engineers at Miami Beach early in November: **Robert A. Brown,** the Arthur Dehon Little Professor at M.I.T., receives the Allan P. Colburn Award; **Ralph Landau,** Sc.D.'41, of Listowel, Inc., the John Fritz Medal; Professor Emeritus **Robert C. Reid,** Sc.D.'54, of M.I.T., an A.I.Ch.E. Founders Award; **Stanley V. Margolin,** '49, president of Network Consulting, Inc., Washington, D.C., the T. J. Hamilton Memorial Award; **David M. Himmelblau,** '44, professor of chemical engineering at the University of Texas at Austin, the Computing in Chemical Engineering Award; **Robert S. Langer,** Sc.D.'74, professor of biochemical engineering at M.I.T., the Food, Pharmaceutical and Bioengineering Division award; and **Ronald E. Rosensweig,** Sc.D.'59, of Exxon Research and Engineering Co., the Alpha Chi Sigma Award. Professor **Daniel I. C. Wang,** '59, of M.I.T. was A.I.Ch.E.'s 38th annual institute lecturer, speaking on "Biotechnology: Status and Perspectives."

John "Jack" Krueger, S.M.'71, has been appointed acting laboratory director for the Maine Bureau of Health. Previously Krueger served as assistant public health laboratory director. . . . **Albert S. Humphrey,** S.M.'49, has been elected a main board director of Norflex Ltd., London., responsible for finance and business development. In the announcement, Norflex noted Humphrey's experience in using a team approach to business development called "Team Action Management."

XI URBAN STUDIES AND PLANNING

Michael Wheeler, visiting professor of law in the department at M.I.T. is now director of education at the M.I.T. Center for Real Estate Development, in charge of a master's program in an area that's gaining growing attending nationwide. Wheeler was formerly director of research and education at the Lincoln Institute of Land Policy, and he's co-author with Professor **Lawrence S. Bacow,** '72, of *Environmental Dispute Regulation.*

William Riley Sims, Ph.D.'74, professor of design and environmental analysis at Cornell University, has been reappointed chairman of the Department of Design and Environmental Analysis for a five-year term. His special interest is in the social and psychological effects of physical environments.

Robert G. Bluhm, M.C.P.'78, is a partner in Beeler and Bluhm, architects and planners, Petaluma, Calif. . . . **James R. Richardson,** M.C.P.'81, assistant professor of planning and architecture at the University of New Mexico (since August 1984), taught in the Beijing Urban Design Studio in collaboration with M.I.T. Associate Professor **Gary Hack,** Ph.D.'76, and Professor Zhu Zhi-Xuan, director of the Teaching and Research Group in Urban Planing, Tsinghua University, Beijing, China. Richardson describes the program: "For the first time since liberation, the studio brought together students from North America and China to work on redevelopment projects in China's capital city." Richardson is also a member of the inter-university research consortium in land-use planning in the Southwest, of the Innovative Educators Group at UNM, and of the committee to review the dual-degree linking community and regional planning with Latin American studies. Richardson holds a 1985-87 Presidential Lectureship Award from the University.

Professor **Rachel G. Bratt,** Ph.D.'76, of Tufts University is co-editor of *Critical Perspectives on Housing* (Temple University Press, 1986, $34.95 and $14.95), a collection of 33 articles that provide what the publisher calls "a complete examination of the structural housing crisis permeating America's cities, suburbs, and rural areas today." In their introduction the editors say, "The gap between the haves and have-nots in America is widening, and housing—as the central expenditure for most lower-income families—reflects this polarization most acutely."

Transmission facilities, not new power plants, are the preeminent issues before public utilities and their regulators in New England, writes **Paul F. Levy,** M.C.P.'74, chairman of the Massachusetts Department of Public Utilities, in the *Boston Globe.* New technology, he says, gives utilities added flexibility in choosing sources of power. But transmission capacity is inadequate for capitalizing on these new advantages. The problem is that transmission systems and technology have received less attention than they deserve from utility managements, regulators, and even educators. "It is time for the utilities to set their long-term goals and help the public understand the essential components of the electric power supply system," writes Levy.

Henry G. Cisneros, mayor of San Antonio (Tex.) and 1986 president of the National League of Cities, has been named an honorary member of the American Institute of Architects. . . . **Lawrence Ogwuche,** '79, a member of the Ministry of Finance and Economic Planning, Makurdi, Nigeria, died in a motor vehicle accident in March 1984; no further details are available.

XII EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

V.T.C. Manohar-Maharaj, S.M.'73, writes, "Transferred from Spain where I was district technical manager to France, where I am now equipment manager for Africa and Southern Europe for Schlumberger Wireline Group." . . . **James A.R. Neilon,** S.M.'65, reports, "After 11 years as chief, Communication Division, National Weather Service Headquarters, Silver Spring, Md., I am now serving NWS as director of international affairs. I am also serving my second four-year term as president of the World Meteorological Organization Commission for Basic Systems."

Charles A. Lin, Ph.D.'79, reports that he left the Department of Physics at the University of Toronto to join the Department of Meteorology faculty at McGill University, Montreal, effective May 1, 1986.

Women, Men on Par in Physics

By all external measures, men and women graduate students in physics at M.I.T. are very much alike. But on the average the women work harder than the men, and their confidence in success is lower, says Professor Mildred S. Dresselhaus.

Women graduate students in physics rate their research performance on a par with that of the men; they present as many professional papers, and they are as likely as men to be first authors. But to achieve these results, says Dresselhaus, writing in *Physics Today,* women spend "significantly more time than men doing research work, and less time than men in leisure activities."

Women feel they have slightly more trouble than men in developing research skills, and they find the pace and pressure of graduate physics study more severe than the men, says Dresselhaus. Furthermore, she reports, "women tend to feel more anxious about exams than men and to feel they haven't done as well, even when the results later turn out to be equivalent."

Dresselhaus' data come from a 1984 survey by the M.I.T. Committee on Women Students' Interests. "The most striking finding," she says, "is the essential similarity between women and men graduate students in physics." Indeed, she says, the average performances of men and women on doctoral exams "are almost exactly the same."

Women represent just under 15 percent of M.I.T. graduate students in physics, which Dresselhaus guesses may be a "critical mass." She believes from her own teaching that when women grow to become 10 to 15 percent of a class, their participation suddenly increases. □

William R. Young, Ph.D. '81, has begun his second year as a member of the M.I.T. faculty, teaching the course in Steady Circulation of the Ocean. His specialty is large-scale ocean circulations, and since completing his M.I.T. degree Young has worked as a research oceanographer at Scripps Institution, San Diego.

The commercial benefits of Strategic Defense Initiative research are nearly as promising as the defense benefits, making SDI "a rare opportunity to enhance comprehensive security with one national effort," wrote **Stewart Nozette,** Ph.D.'83, in the *New York Times* last spring.

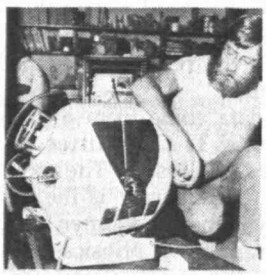
Nozette, who's a member of the faculty and vice-president of the Large-Scale Program Institute at the University of Texas, Austin, had just helped host a conference on commercializing SDI technology.

Norman E. Gaut, Ph.D.'64, is now president and chief executive officer of PicTel Corp., Peabody, Mass., developers of visual telecommunica-

"It Was Kind of Eerie" Down There

During three weeks aboard *Atlantis* last summer, W. Kenneth Stewart, a graduate student in the M.I.T.-Woods Hole oceanography program, was the "resident expert" in microprocessor control. His job was aboard *Alvin*, the three-person deep-submergence vehicle that travelled to the wreck of the *Titanic*, 12,500 feet below the surface of the North Atlantic; and his assignment was to operate *Jason, Jr.*, the unmanned vehicle that explored the *Titanic*'s inner passages.

That matter-of-fact tone reflects Stewart's attitude perfectly. He's been project engineer for more than two years on WHOI's small vehicle program, of which *Jason, Jr.* is the culmination to date. "From a technical standpoint, it was a combination of what I'd been working on for the last four years," Stewart told Sharon Davis of the M.I.T. News Office.

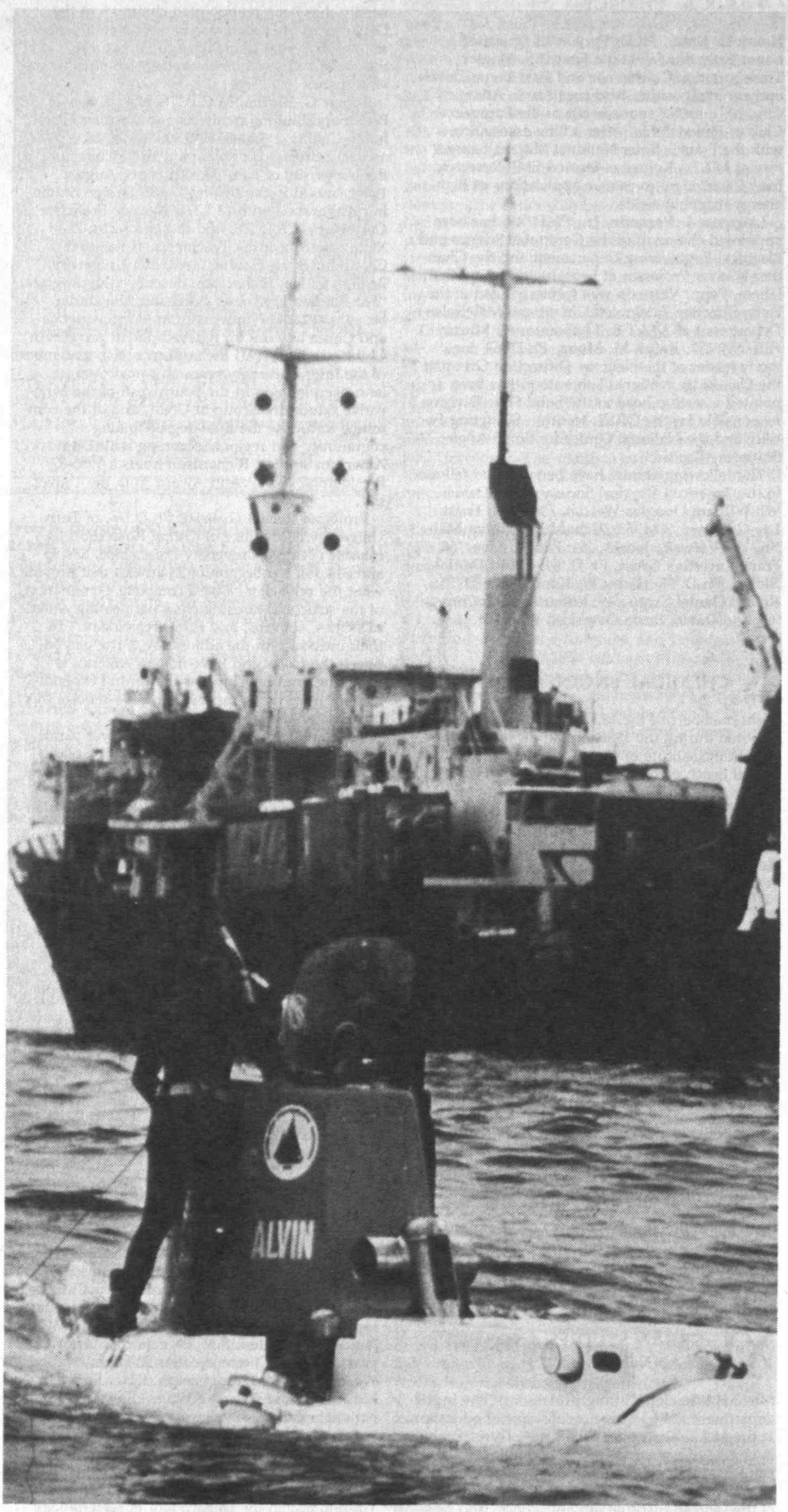


But Stewart admits there was more to it. Diving on the *Titanic* was like approaching "a kind of ghost town," Stewart says—"it was kind of eerie."

Each of the dives to the *Titanic* lasted eight hours—"five hours of commuting down to the site and back and three hours on the job. Most of the time we were down there we were working real fast to take advantage of the limited time. So we really didn't have time to think too deeply about the whole experience until we got up on the surface."

The ultimate goal of Stewart's WHOI group is to build a full-size version of *Jason, Jr.*, an unmanned robot that will carry sonar and video imaging as a partner of *Alvin*. *Jason, Jr.*, is in fact the third-generation prototype—"the culmination of efforts on everybody's part."

Will *Alvin/Jason* continue explorations of the *Titanic*? Stewart thinks not; indeed, he says there are no plans to return. "We really accomplished what we set out to do." □



Right: Alvin *returns to* Atlantis *after a dive on the* Titanic *last summer.* Inset: *W. Kenneth Stewart with* Jason, Jr., *the unmanned vehicle for whose controls he was responsible.*

PHOTOS: WOODS HOLE OCEANOGRAPHIC INSTITUTION

tions products for use with common-carrier telephone lines. Gaut had been a director of PicTel while serving as president of Environmental Research and Technology, Inc., of which he was cofounder in 1968 with M.I.T. professor **David H. Staelin,** '60. . . . Second Lieutenant **Pamela A. Melroy,** S.M.'84, recently graduated from U.S. Air Force pilot training and received silver wings at Reese Air Force Base, Tex. Melroy is now serving at Barksdale Air Force Base, La. . . . **Edward P. Laine,** Ph.D.'77, has been appointed first director of Bowdoin's new Environmental Studies Center as well as assistant professor in the Geology Department. Laine, a geologist and oceangrapher, was associate research professor at the University of Rhode Island.

XIII OCEAN ENGINEERING

Webster L. (Lance) Benham III, S.M.'77, has been named senior vice-president for corporate operations of The Benham Group, Oklahoma City, responsible for overseeing the firm's financial affairs, property management, and personnel. Benham was previously executive vice-president of the company's division office in Washington, D.C.

XIV ECONOMICS

Richard S. Eckhaus, Ph.D.'54, Ford International Professor of Economics who had served as associate head of the department at M.I.T., is now head, succeeding Professor **Peter A. Diamond.** Eckhaus has specialized in the economic problems of developing countries; he studied at Iowa State and Washington Universities and from 1954 to 1962 was a member of the Economics Department at Brandeis.

Charles P. Kindleberger, Ford International Professor of Economics, Emeritus, at M.I.T. has been named a James S. McDonnell Distinguished Scholar at the World Institute for Development Economics Research (WIDER) in Helsinki, Finland. Kindleberger, a specialist in international economics, is also Sachar Visiting Professor of Economics at Brandeis University. . . . **Scott E. Pardee,** Ph.D.'62, former executive vice-president of Discount Corp., New York City, is currently vice-chairman of Yamaichi International (America), Inc.

George C. Galster, Ph.D.'74, reports that he has been promoted to professor of economics at College of Wooster (Ohio) and is co-author of *Dynamics of Neighborhood Change and Decline* (Pergamon Press). . . . **Donald H. Layton,** S.M.'72, is senior managing director for the Asset/Liability Unit of the Manufacturers Hanover Corp., New York City; formerly he served as senior vice-president of the firm's Treasury Unit.

XV MANAGEMENT

Professor **Thomas L. Magnanti** has a new assignment: co-director (with Professor Amadeo Odoni of aeronautics and astronautics) of the M.I.T. Operations Research Center. Magnanti is a specialist in mathematical programming for large-scale systems and transportation planning, a member of the Sloan School faculty since 1971 and head of the school's Management Science Area since 1982.

Robert S. Hamada, Ph.D.'69, deputy dean of the Business School at the University of Chicago, has been elected a director of Manville Corp., Denver, Col. . . . **Kenneth R. Hootnick,** S.M.'61, is currently executive vice-president and chief operating officer of Dicomed Corp., Minneapolis, Minn. Hootnick was formerly president of Butler Computer Graphics, Inc.

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Sloan Fellows

Two announcements from the Eastman Kodak Co., Rochester, N.Y.: **J. Phillip Samper,** S.M.'73, has become vice-chairman and executive officer of the Information Management Division; formerly, Samper was executive vice-president and general manager of the division. And **Kay R. Whitmore,** S.M.'75, president and director of Eastman Kodak Co., has taken on the additional post of executive officer. . . . **Sam R. Willcoxon,** S.M.'65, is group president for business markets at American Telephone and Telegraph Co., New York City. Formerly, Willcoxon was executive vice-president of AT&T Communications.

Guy W. Nichols, S.M.'61, has been elected to a three-year term as a trustee of the Worcester Foundation for Experimental Biology, Shrewsbury, Mass. Nichols recently retired as chairman of the New England Electric System, and he is chairman of the board of Woods Hole Oceanographic Institution. . . . **William G. Kay, Jr.,** S.M.'63, president of Wentworth Management Group, a private investment and management consulting company, Radnor, Penn., has been elected to the Board of Directors of The Bachman Co., Reading, Penn. Kay's experience includes executive assignments with Sun Co., Campell Soup Co., and president of Standard Brands, Inc.

James W. McCurdy, S.M.'82, is assistant vice-president of the International Division at the First Interstate Bank of Washington (Seattle). . . . **Carol M. Taylor,** S.M.'82, reports her activities: since September 1984 assistant director—marketing, Office of Technology Licensing and Industry-Sponsored Research, Harvard Medical School; and on March 9, 1985, Frederick Openshaw Taylor Deknatel was born. . . . **William E. Barton,** S.M.'81, reports from Brooklyn, N.Y., that he has been promoted (effective early in 1986) to director, WW Credit Control at American Express; he is an active member of the Executive Board for the New York City Sloan Club; and his son William Frederick Tith Barton (Billy) was born on September 17, 1985.

Michael Gauthier, S.M.'82, with Temple, Barker and Sloane, Inc., Lexington, Mass., since 1983, has been elected a principal of the firm. . . . **Ira Benjamin Artman,** S.M.'80, a financial analyst with the Security Pacific Financial Strategies Group, New York City, married Amy Lynn Preminger on November 11, 1985. . . . **Michael B. Green,** S.M.'76, has been appointed assistant executive director for fiscal services at Nashua (N.H.) Memorial Hospital. . . . **Cathy M. Carron,** S.M.'84, has been assistant to the president at Master Card International, New York City, since October 1985.

Senior Executives

Gainor J. Lindsey, '79, has been promoted from vice-president and general manager of the Customer Support and Service Division to senior vice-president of Commercial Business of Bell Helicopter Textron, Inc., Providence, R.I. Also at Bell Helicopter Textron, Inc., **Charles R. Rudning,** '71, has changed jobs: formerly senior vice-president, programs, he is now senior vice-president, government business. . . . **Heinz K. Hofmeister,** '74, has been promoted from manager of Corporate Planning to executive vice-president of American Hoechst Corp. . . . **Edward J. Mooney,** '79, has been promoted from vice-president for human resources to president of the Petroleum Division at Nalco Chemical Co., Oak Brook, Ill.

Herbert Kay, '68, has been elected a vice-president of the National Executive Services Corp., New York City, an "organization which helps nonprofits by providing a superior calibre of retired executives as consultants." Kay, who first studied at M.I.T. as a graduate student in chemical engineering (S.M.'47), was affiliated with Amax, Inc., from 1955 until his retirement as a vice-president (corporate officer for engineering and technology) in 1985. At NESC, Kay is working on programs to improve the teaching of mathematics and science education in elementary and secondary schools. . . . **Frank M. Burke, Jr.,** '82, chairman, chief executive officer, and managing general partner of Burke, Marwick, Mitchell and Co., Dallas, has been asked by the Secretary of Energy, John S. Herrington, to serve on the National Petroleum Council. As an investment counselor, Burke specializes in energy and natural resources issues.

Gordon H. Millar, '66, has been appointed president of the Florida-based (Daytona Beach) advanced automotive technology firm of MotorTech, Inc. Millar was president of the Society of Automotive Engineers in 1984-85, before retiring from his post as vice-president—engineering of Deere and Co. . . . **Donald E. Procknow,** '63, retired on February 13, 1986, as vice-chairman of AT&T Technologies, Inc., New York City. . . . **John T. Probst,** '61, of Mishawauka, Ind., passed away on December 9, 1980; no further details are available.

Management of Technology Program

Moises J. Goldman, S.M.'84, called to say "hello" last August 19. . . . **Carol M. Lemlein,** S.M.'83, wrote in August that she had moved to Santa Monica and that this was supposed to be an "antidote for my workaholic tendencies!" Her daughter, Sandra, is a freshman at the Rhode Island School of Design, and her older daughter, Karen, spent the summer in the office of Connecticut Congresswoman Nancy Johnson before returning to Northwestern's School of Journalism this fall, where she is a junior.

Terrence C. Leslie, S.M.'86, telephoned over the summer to say he was enjoying his work on a long-term development program for IBM's General Technology Division. He was in Sweden for one week on the job and planned to go back after Labor Day. He talked with **Jack L. Jarkvik,** S.M.'86, the first visit and hoped to spend a weekend with him the second time around. Terry's Vermont house was sold, and their new home in Danbury, Conn., is much larger, he said. His wife, Mary, has a management position near Poughkeepsie.

Julian Nikolchev, S.M.'83, came by the office last August 18 and visited with Jane Morse. He's enjoying his current project with SRI International on university/industry relations and was at M.I.T. and in the Boston area on business. Betsy and the children are doing well: Alexandra is now three and one-half, and Anthony is six months. Julian is hoping to interview more Program graduates this year for positions at SRI. . . . **Graydon Wheaton,** S.M.'86, and his wife, Iris, stopped by the office in August. Grady was recuperating well from surgery after his moped accident on Nantucket.

The Management of Technology Program made news at M.I.T. last summer with the announcement that our current class of 28 is the largest in our six-year history. Twenty percent of the participants are international and two-thirds are sponsored by companies with whom they're employed—the latter including, this year, IBM (five students), the U.S. Air Force (two students), and (one student each) Digital Equipment, Eastman Kodak, BellSouth, Data General, Electric Power Research Institute, the U.S. Army, British

The 102-foot fiber-reinforced plastic wing for the* Michelob Light Eagle, *designed to break the world distance record for human-powered aircraft, passed this test for strength in a hangar at Hanscom Field, Bedford, last summer. Plastic bottles holding varying amounts of water were suspended from the wing to replicate the stresses of flight.



PHOTO: STEVE FINBERG, '77

Petroleum, Pilkington Brothers, GEC Hirst Research, and Shimizu Construction of Japan.—Jane Morse, Program Manager, Management of Technology Program, M.I.T., Room E52-125, Cambridge, MA 02139

XVI AERONAUTICS AND ASTRONAUTICS

A specialist in transportation systems analysis, airport design and operation, and air traffic control, Professor **Amedeo R. Odoni,** '65, is now co-director of the M.I.T. Operations Research Center. He shares with Professor **Thomas L. Magnanti** of the Sloan School of Management the task of creating "a major new initiative in the decision sciences at M.I.T.," as recommended by a review committee appointment by **John M. Deutch,** '61, provost.

Preliminary plans are complete for "Spacefair '87," a national exhibition and conference scheduled at M.I.T. on April 10-12. The theme centers on a proposal for an "International Space University," which will be discussed at the conference by a wide range of experts in aerospace and education. Chairman of the Spacefair is **Peter H. Diamandis,** '83, who's now a graduate student in aeronautics and astronautics at M.I.T. while he also studies for an M.D. at Harvard Medical School. Diamandis is also the founder of Students for the Exploration of Space, an advocacy group that now has chapters at 35 universities in five countries, and of the Space Generation Foundation, an organization for space enthusiasts born—like Diamandis—since Sputnik.

Professor **Robert C. Seamans, Jr.,** Sc.D.'51, senior lecturer in the Department of Aeronautics and Astronautics and former dean of the School of Engineering at M.I.T., has been elected to the Board of Overseers at New England Medical Center. . . . **James H. Doolittle,** Sc.D.'24, retired as director of the Mutual of Omaha Insurance Co. . . . **Martin C. Jischke,** Ph.D.'68, chancellor of the University of Missouri, Rolla, has been appointed by Missouri Governor John Ashcroft to the Missouri Corporation for Science and Technology. Before moving to Missouri Jischke was dean of the College of Engineering and interim president at the University of Oklahoma.

Robert W. Mann, Jr., S.M.'77, has been promoted from systems director—marketing plans and programs to general manager—marketing at Pan American World Airways, New York City. Mann is responsible for Pan Am's direct consumer, agency and employee marketing programs as well as for developing the company's own marketing plans.

Frank L. Wattendorf, S.M.'28, for 16 years director of the NATO's Paris-based Advisory Group on Aeronautical Research and Development until his retirement in 1968, passed away on June 11, 1986. Wattendorf, a specialist in wind tunnels, taught in China in the late 1930s, and his Washington career included two years in the Engineering Development Division of the Department of Defense as chief scientific adviser. Wattendorf received the Medal of Freedom, the civilian military recognition award, in 1946.

XVII POLITICAL SCIENCE

To Professor **Eugene B. Skolnikoff,** Ph.D.'65, who headed the M.I.T. Center for International Studies from 1970 until early this year, the Commander's Cross of the Order of Merit of the Federal Republic of Germany. Skolnikoff was lauded for "personal contributions to a better understanding between our two countries" as director of CIS and as chairman (since 1979) of the Board of Trustees of the German Marshall Fund.

Professor **W. Russell Neuman** of M.I.T. is the author of *The Paradox of Mass Politics: Knowledge and Opinion in the American Electorate* (Harvard University Press, 1986, $29.95 and $12.50). Moved by the paradox of a democracy the majority of whose citizens are only marginally involved in politics, Neuman analyzes U.S. elections from 1948 to 1980 and concludes that a politically sophisticated elite in the U.S., composing less than 5 percent of the population, is so active and articulate that its views are often equated with public opinion at large.

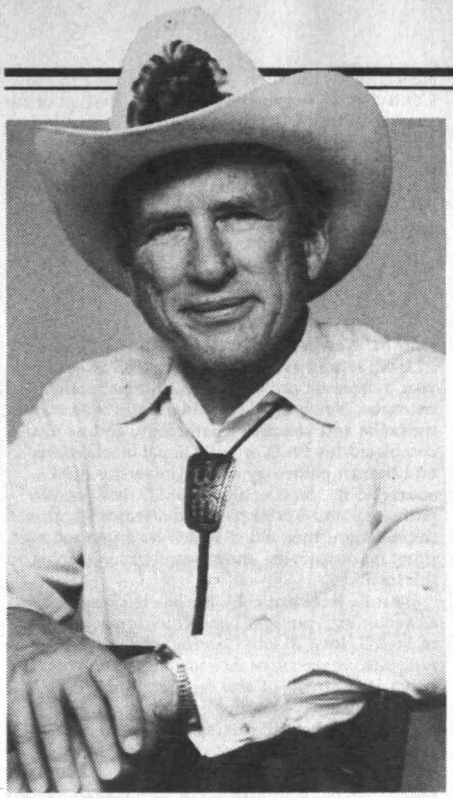
Another important book from the department published this fall is *Consuming Fears: The Politics of Product Risks* (New York: Basic Books, 1986, $18.95), the work of four graduate students of Professor **Harvey M. Sapolsky,** for whom Sapolsky served as editor. It's a study of the political dynamics surrounding six controversial, risky products—cigarettes, dairy and meat products, salt and artificial sweeteners, tampons, and urea-formaldehyde insulation. The authors are **Linda C. Cummings,** Ph.D.'84, program manager of the Massachusetts Department of Commerce and Economic Development, Boston; **Janet M. Levine,** Ph.D.'86, **Mark J. Segal,** Ph.D.'85, director of the Department of Health Financing of the American Medical Association, Chicago: and **Sanford L. Weiner,** research associate the Whitaker College of M.I.T.

Professor **Neil Chourcri** heads an interdepartmental committee responsible for a new M.I.T. graduate study program on the Middle East inaugurated this fall. Its emphasis is on technology, development, and policy, and Choucri says the program "fills a gap by focusing on technological changes, institutional adaptations, and challenges to development arising from infrastructure and social changes. We want to emphasize policy issues and improve policy analysis," she says, with the goal of helping prepare students for work on Middle East-related issues within their chosen fields.

Professor **Lincoln P. Bloomfield** of M.I.T. is author of the concluding chapter in *How Peace Came to the World* (Cambridge: M.I.T. Press, 1986), an account of the *Christian Science Monitor*'s "Peace 2010" contest. In "Imagination and Responsibility: Dilemmas in Translating Creative Ideas Into Action," Bloomfield notes that East-West detente will require "all the ideas inventive people can think of." Hence, he says, the validity of the *Monitor*'s concept for the contest; indeed, Bloomfield writes, "the flow upward of policy proposals is a key strength of democracy."

Professor **Willard R. Johnson** of M.I.T. will spend the first eight months of 1987 in the Ivory Coast, studying the African Development Bank and its relationship to volunteer and philanthropic help to counter famine and drought. Johnson's research is financed by a Fulbright grant; he is a specialist in African politics and economic development.

Having handily won the Republican nomination in the Massachusetts primary, **Clark C. Abt,** Ph.D.'65, spent September and October in a vigorous campaign for election to Congress from the Massachusetts Eighth Congressional District. "Very few congressmen, possibly none, . . . have my set of experiences in technology, enterprise development, and overall economic and social problem solving," Abt told a meeting of the M.I.T. Republican Club. At the same meeting he identified himself with the Strategic Defense Initiative as a means "to increase deterrence of nuclear war. . . . Its purpose is to maintain the balance of power." With the Massachusetts Republican organization in considerable disarray, most observes gave Abt little chance against Democrat Joseph P. Kennedy II.



Richard Johnson, Ph.D.'52, president of Watkins Johnson Co., Palo Alto, is one of 63 "Silicon Valley pioneers" whose portraits in word and picture appear in Portraits of Success ***by photographer Carolyn Caddes (Palo Alto: Tioga Publishing Co., $40). "I'm a man who plugs along and tries to make things happen," Johnson told Ms. Caddes, "a man who has always been a little lucky." Other alumni in Caddes' book of portraits in picture and word include Paul M. Cook, '47, president of Raychem Corp.; Professor Emeritus Marvin Chodorow, Ph.D.'39, of Stanford; William R. Hewlett, S.M.'36, vice-chairman of the Board of Hewlett Packard Co.; Robert N. Noyce, Ph.D.'53, vice-chairman of Intel Corp.; Thomas J. Perkins, '53, partner in Kleiner and Perkins, San Francisco; William Shockley, Ph.D.'36, consultant; and the late Frederick E. Terman, '24, dean of engineering and vice-president of Stanford.***

XVIII MATHEMATICS

After reporting to the American Mathematical Society that "we have begun to make friends on Capitol Hill, to develop basic understanding of the varied important roles of mathematics, and to suggest how Congress can help us," Professor **Kenneth M. Hoffman** of M.I.T. was cited by his mathematics colleagues for his work as director of federal relations for the Joint Policy Board for Mathematics. JPBM represents the Mathematical Association of America, American Mathematical Society, and Society for Industrial and Applied Mathematics, and Hoffman's award was a feature of the SIAM annual meeting in Boston last summer.

Richard Haberman, Ph.D.'71, associate professor of mathematics in Dedman College of Southern Methodist University, Dallas, has been named chairman of the Mathematics Department. . . .

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SERVING THE SCIENCE COMMUNITY SINCE 1953

Russell L. Mallett, Ph.D.'70, joined the Process Control and Computer Technology Division of Alcoa Laboratories, Alcoa Center, Penn., as a technical specialist. For the past 15 years, Mallett served on the faculty at Stanford University, teaching applied mathematics, mechanics, and space technology and performing research in large deformation metal forming analysis.

XX APPLIED BIOLOGICAL SCIENCES

Paul M. Newberne, who joined the M.I.T. faculty in 1962, retired at the end of the 1985-86 academic year to become professor of nutritional pathology, emeritus. Newberne holds degrees in veterinary medicine and veterinary pathology, and he also completed his Ph.D. in nutritional biochemistry and human pathology at the University of Missouri (1958). His specialty at M.I.T. has been in pathology and biochemistry of diseases of nutritional origin, the field in which he organized a program of teaching and research upon coming to the Institute.

John K. Buckner, S.M.'60, has left his position as senior vice-president and chief financial officer of EG&G, Inc., to join Control Data Corp., Minneapolis, as executive vice-president and chief financial officer. . . . **Carol N. Meredith,** Ph.D.'82, reports, "I am continuing in research on metabolism and nutrient requirements in aging at the Human Nutrition Research Center on Aging, Tufts University, Boston. My husband, **Julio Salinas,** Ph.D.'80, is director of in vivo toxicology at a testing laboratory in Fall River." . . . **Alina S. Szczesniak,** Sc.D.'52, received in June, 1985, the Nicholas Appert Medal, the highest award that the Institute of Food Technologists bestows upon its members. She is the first women to receive it.

XXI HUMANITIES

The Program in Science, Technology and Society at M.I.T. has new leadership: **Kenneth Keniston,** Andrew W. Mellon Professor of Human Development, has succeeded **Carl Kaysen** as its head; Kaysen has returned to full-time teaching as David W. Skinner Professor of Political Economy. Keniston is noted for his work in child development and adolescence; he came to M.I.T. in 1976 from Yale, where he was professor of psychiatry and director of the Behavioral Sciences Study Center and of a training program in social and community psychiatry. . . . **Claire Kramsch,** professor of foreign languages and literatures at M.I.T., is now section head in the Department of Humanities; she is a specialist in the methodology of learning foreign languages—a field in which she has been working at M.I.T. since 1965.

XXII NUCLEAR ENGINEERING

Troubled by the cloud that deepened over the nuclear power industry after the Chernobyl accident, **Vincent P. Manno,** Sc.D.'82, assistant professor of mechanical engineering at Tufts University, says it would be "technically stupid" for the U.S. to ignore the option of nuclear power. "My belief is that you don't throw a proven technology away," said Manno in a Tufts University press release; he views nuclear reactors as "good machines that need improvement," he says. The trouble really began in the 1960s and 1970s, when the size of reactors being built in the U.S. grew rapidly—"the fastest scaleup of any engineering enterprise in the history of technology." Now Manno is working part-time at M.I.T. to improve and simplify future plants. "So much about nuclear plant design is folklore as opposed to engineering," he says. "When you talk to people who designed early plants, they say, 'We did it, it worked, and we left it that way.' "

XXIV LINGUISTICS AND PHILOSOPHY

The wide array of moral considerations that bears on all but the simplest problems is the theme of Professor **Judith J. Thomson** of M.I.T. in *Rights, Restitution, and Risk: Essays on Moral Theory,* published this fall by Harvard University Press. Thomson is described by the publisher as "a philosophical analyst of the highest caliber who can tease a multitude of implications out of . . . a mere bit of eavesdropping."

Fans of Chinese cooking who can't read a Chinese menu can give thanks to **James D. McCawley,** Ph.D.'65, professor of linguistics at the University of Chicago; he's the author of *The Eater's Guide to Chinese Characters* (University of Chicago Press, 1984, $5.95). Though McCawley knows several languages, Chinese (except for menus) is not one of them; all he wants of Chinese, he says, is to be treated "as a real customer, not a interloper," when he ventures forth to fulfill his frequent cravings for Chinese food.

TECHNOLOGY AND POLICY PROGRAM

Steve Korthals-Altes, S.M.'86, spent the summer working for the Rockwell International Corp. on a further analysis of the "space plane" program that was his thesis topic . . . **Dan Saltzman,** S.M.'80, is serving as issues manager on environment for Neil Goldsmith, Democratic candidate for governor of Oregon and former U.S. secretary for Transportation. Dan is also vice-chairman of the Citizens' Advisory Committee on a Nuclear Waste Site for Oregon. . . . **Rick Hornby,** S.M.'79, is now an associate scientist at Energy Systems Research Group, Boston.—Richard de Neufville, Chairman, Technology and Policy Program, M.I.T., Room 1-138, Cambridge, MA 02139






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M. Stanley Livingston

M. Stanley Livingston, 1905-1986
Pioneer in Nuclear Accelerators

Professor Emeritus M. Stanley Livingston, a pioneer in the design and construction of high-energy accelerators, died on August 25 in Santa Fe, N.M., at the age of 81.

Professor Livingston came to M.I.T. in 1938 to build the Institute's cyclotron, which he subsequently used for high-energy physics research and—during World War II—for the production of radioactive materials. By 1956 he was the first director of the Cambridge Electron Accelerator, developed and built under his supervision as a joint project of M.I.T. and Harvard. From 1946 to 1948, he had been on leave to head the building of a 3-billion-electron-volt cosmotron at Brookhaven National Laboratory.

Professor Livingston began work on a 200-billion-electron-volt proton accelerator at the National Accelerator Laboratory in Batavia, Ill. in 1967. By 1970, when he retired from the M.I.T. faculty, Livingston was associate director of that laboratory.

Professor Livingston studied for his doctorate (1931) with Professor E. O. Lawrence at the University of California at Berkeley, and his thesis was the original research on the cyclotron principle; he remained at Berkeley for four years to develop and build the first U.S. cyclotron and then went to Cornell to work in experimental nuclear physics with Professor Hans A. Bethe. Before going to Berkeley, Livingston had studied at Pomona and Dartmouth.

Throughout his active professional life, Livingston was regarded as one of the world authorities on the design, construction and use of high-energy machines. He was also active in undergraduate teaching and in professional affairs. He served two terms as national chairman of the Federation of American Scientists, and he was also a long-standing member of the Committee for a Sane Nuclear Policy; in both groups he was in the forefront of scientists seeking to end nuclear testing.

Deceased

The following deaths have been reported to the Alumni Association since the *Review*'s last deadline:

Theodore D. Parsons, '16; May 23, 1986; Hanover, N.H.
John M. DeBell, '17; July 12, 1986; Enfield, Conn.
Mary Hall, '19; July 6, 1986; Moorestown, N.J.
Karl L. Nutter, '19; August 15, 1986; Needham, Mass.
Carl L. Svenson, '19; July 31, 1986; Milton, Mass.
Clarence H. Sorum, '20; January 10, 1986; Madison, Wisc.
John W. Shepard, '21; August 10. 1986; Stamford. Conn.
Broderick Haskell, '22; September 1, 1986; Meriden, Conn.
Robert L. Hallock, '22; September 2, 1986; Needham, Mass.
Julian B. McFarland, '22; July 9, 1986; Menlo Park, Calif.
Eldor J. Mink, '22; 1984; New Cumberland, Penn.
C. Randolph Myer, Jr., '22; July 22, 1986; Wilton, N.H.
Theodore P. Shlifloff, '22; April 10, 1986; Guntersville, Ala.
Arthur Slepian, '22; May 22, 1986; Bridgeport, Conn.
John Huling, Jr., '23; May 6, 1986; Whitewater, Wisc.
Mrs. William Webster, '23; 1985; Cambridge, Mass.
Norman L. Weiss, '23; June 1986; Tucson, Ariz.
William E. Delehanty, '24; July 7, 1986; New York, N.Y.
Elwood M. Proctor, '24; July 11, 1986; St. Louis, Mo.
John H. Skinkle, '24; August 2, 1986; Andover, Mass.
Willard C. Asbury, '25; April 29, 1986; Westfield, N.J.
Hollis F. Ware, '25; December 28, 1985; Midland Park, N.J.
Fred M. Harrington, '27; April 27, 1986; Peekskill, N.Y.
Abraham Mankowich, '27; January 19, 1983; Bel Air, Md.
Donald A. Sherman, '27; July 10, 1986; Medford, N.J.
Robert E. Murphy, '28; July 6, 1986; Flushing, N.Y.
Donald R. Funk, '29; January 14, 1986; Cherry Hill, N.J.
Henry J. Herrel, '29; July 2, 1986; Bangor, Maine.
Ernest W. Reisner, '30; May 11, 1986; Fairfax, Va.
William J. Wye, '30; August 17, 1986; South Boston, Mass.
Rufus K. Dryer II, '32; December 23, 1985; Rochester, N.Y.
Harry Shwachman, '32; September 9, 1986; Needham Heights, Mass.
Gardner W. Hicks, '33; July 13, 1986; Tiverton, R.I.
William C. Hinckley, Jr., '33; May 29, 1986; Chelmsford, Mass.
Leonard P. Blakely, '36; April 27, 1986; Towaco, N.J.
Wells Coleman, '37; May 28, 1985; Rochester, N.Y.
Richard Surbeck, '37; July 1986; Orleans, Mass.
Richard G. Robertson, '40; June 30, 1986; Freedom, N.H.
Hubert B. Reece, '41; April 16, 1986; Langley, Wash.
Edgar F. Smith, '41; September 4, 1981; Kirkland, Wash.
Allen P. Winsor, Jr., '41; May 13, 1986; South Dartmouth, Mass.
Sanford J. Neuhaus, '45; March 24, 1986.
Walter R. Connell, Jr., '48; August 1, 1986; Manitou Beach, Mich.
Joseph C. Fantone, Jr., '48; July 17, 1986; Needham, Mass.
Arthur H. Ballard, '50; July 4, 1986; Bethesda, Md.
Richard E. Glenn, '50; January 1, 1981; Lutherville, Md.
Richard William Morton, '52; August 30, 1986; Larchmont, N.Y.
Paul S. Randazzo, '77; May 15, 1985; Millington, N.J.
William N. Schaffner, '77; August 26, 1986; Denver, Colo.

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M. J. Barvenik, '76
D. M. Brown, '81
M. D. Bucknam, '81
N. A. Campagna, Jr. '67
F. W. Clark, '79
K. A. Fogarty, '81
W. E. Hadge, '79
C. A. Lindberg, '78
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ALLAN J. GOTTLIEB

A Tight Spot for the Piano Movers

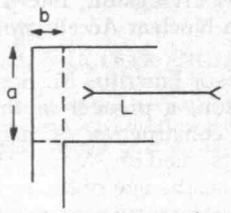
Several readers have made comments that I wish to pass on. Longtime contributor Frank Rubin runs a series of contest puzzles. For details write to "The Contest Center," P.O. Box 1660, Wappingers Falls, N.Y. 12590. Mary Lindenberg's contributions to *Puzzle Corner* have been cited by her local newspaper. Finally, Dudley Church seems to be starting a fan club; he writes, "If Harry Zaremba is not a mythical character, he is undoubtedly one of the premier puzzle solvers of the age."

Problems

N/D 1. Lawrence Kells writes that a friend of his directed a duplicate bridge tournament in which every hand was played 20 times. Not being noted for its bidding expertise, this section produced a strange result on Board 14. At four of the tables the final contract was one club, played once from each of the four sides. At four of the other tables it was played at one diamond once from each side. Likewise, at the remaining tables it was played once from each side at one heart, one spade, and one no-trump. Every one of these contracts was set. Analysis of the hand proved that none of the declarers made a mistake in play. Unfortunately, Mr. Kells failed to see what the deal was. Can you reconstruct it? (That is, a deal where any contract anybody bids can be set no matter how hard succesful bidder tries to make it.)

N/D 2. Our next problem is from Harry Zaremba. A certain polyhedron has nine vertices, and each of its faces is a triangle. How many faces does the figure have? If six faces meet at each of three vertices, what common number of faces meet at each of the other vertices?

N/D 3. Ruben Cohen offers a problem he hopes will be helpful to students who need to change apartments each year. Since this is one form of the "piano-movers" problem, the students are presumably music majors. Mr. Cohen writes that some students need to move a board of length L through a corner as shown below.



What is the maximum length board that can pass through?

N/D 4. 1985 Oct 4 reminds Albert Mullin of the following problem, first submitted to *American Mathematical Monthly* by Fred Jamison in 1951:

Any one of a group of airplanes may be refueled from any other. Each has a fuel capacity sufficient for a flight one-fifth the distance around the earth. Assuming that all have the same constant ground speed and the same rate of fuel consumption, that the only landing place and the only available fuel supply are at the home base, and that refueling time is negligible, find the minimum number of planes necessary so that one plane may fly around the earth and all return home safely.

N/D 5. A former colleague of mine, Ned Staples, would like you to find a method of converting an arbitrary (legal) position in a tower of Hanoi puzzle into another arbitrary position. In the tower of Hanoi puzzle, we have M discs of differing radii distributed on three pegs with no disc on top of a smaller one.

Speed Department

SD 1. Phelps Meaker recalls that the formula $\cos^2\pi/N$ came up when studying regular polygons having N sides. In what way?



SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012.

SD 2. L. Upton wants an economical representation for 2.34567 (to the nearest fifth place) and recommends using a hand calculator.

Solutions

JUL 1. The contract is six hearts by South, East having bid spades. With an opening lead of ♠7, how can South fulfill the contract?

	♠ A J 9 8 ♥ Q 9 ♦ Q 5 4 2 ♣ 4 3 2	
♠ 7 6 5 ♥ 3 2 ♦ J 10 9 6 ♣ J 9 6 5		♠ K Q 10 4 3 ♥ 8 7 6 ♦ A 3 ♣ Q 10 8
	♠ 2 ♥ A K J 10 5 4 ♦ K 8 7 ♣ A K 7	

The following solution is from Jacob Bergmann: South takes the opening trick with the ♠A and leads a low diamond. If East does not win immediately, you win the ♦K; continue with a low diamond from both hands and you lose that trick. In either case, you establish two top diamond winners and retain the ♦Q in dummy. Now let East return a club (his best shot). Win the ♣A and run off all the trumps, reducing to

♠ J
♥ -
♦ Q 5
♣ 4

♠ -
♥ 5
♦ 8
♣ K 7

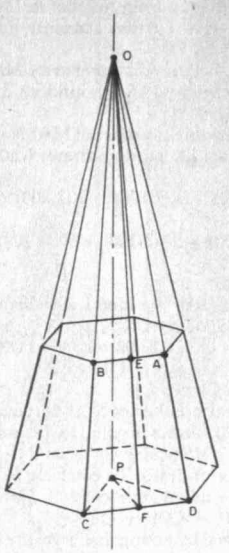
The type B1 double squeeze is now in order. On the last trump, West must reduce to a singleton club in order to guard diamonds; you discard the ♦5 from dummy, cross to the ♦Q, and East is squeezed in the black suits.

Also solved by Ned Staples, Joe Feil, Bruce Levy, Douglas VanPatter, Matthew Fountain, Richard Hess, Jacob Bergmann, Robert Bart, Timothy Maloney, Yale Zussman, Michael Strieby, Warren Himmelberger, and the proposer, Winslow Hartford.

JUL 2. A six-sided lampshade assembled from parchment trapezoids is larger at the bottom than at the top. The two parallel sides and the height of the trapezoids are in the ratio 2:3:4. How much does a side slope from the vertical?

The following response is from James Abbott: As usual, the solution took me a lot less time than the documentation! For this one, I made a set of panels according to the specification and put them together with tape. Some of the resulting shapes are fascinating possibilities for lampshades. The structure as specified is not rigid and can assume any shape with a six-sided cross section (including re-entrant shapes such as a three-pointed star). However, for lack of any other specification I am assuming it to be a frustum of a regular hexagonal pyramid.

The figure is oriented to show the center of the base and associated construction lines useful to the solution. In the figure, ABCD is one of the six trapezoidal faces, O the vertex of the pyramid, and P the center of the base. Since the base is by definition a regular hexagon, it follows that PCD is an equilateral triangle. Let E and F be the respective midpoints of AB and CD. Then, since in a regular pyramid all faces are congruent by definition, OC = OD. Also, PC = PD since PCD is equilateral. Triangles OFC and OFD are congruent; hence angles OFC and OFD are equal right angles and OF is perpendicular to CD. Similarly, PF is also perpendicular to CD. Therefore, the angle PFO measures the dihedral angle between the planes determined by OCD and PCD. The complement of this angle, or POF, will be the slope asked for.



The statement of the problem gives the ratio of AB:CD:EF as 2:3:4. For simplicity of expression let us specify a unit such as that AB = 2, CD = 3, and EF = 4. Then by the rules of similar figures,
OE/OF = 2/3, or OE = (2OF)/3.
Since EF = OF − OE (from the figure), we have
EF = OF − (2OF)/3 = OF/3, whence
OF = 3EF = 3 × 4 = 12.
Since PCD is an equilateral triangle, angle PCF = 60°.
PF = PC sin 60° = CD sin 60° = 2.5981.
Finally, angle POF = arcsin (2.5981/12) = 12.5039°.

Also solved by Ned Staples, Jacob Bergmann, Greg Spradlin, Harry Zaremba, James Abbott, John Cushnie, Ken Rosato, Kurt Eichenberger, Mary Lindenberg, Matthew Fountain, Peter Wender, Richard Hess, Robert Bart, Ronald Martin, Michael Gennert, Steve Feldman, Winslow Hartford, Naomi Markovitz, P. Michael Jung, John Langhaar, Dennis White, Yale Zussman, and the proposer, Phelps Meaker.

JUL 3. Find a pattern or better yet a closed form for f(n) defined by:
f(1) = 1
f(n) = f[n − f(n − 1)] + 1 for n > 1

George Thomas sent us the following solution. The pattern is 1,2,2,3,3,3,4,4,4,4,5,5,5,5,5,..., i.e. one 1, then two 2's, etc., and a closed form that fits that pattern is

$$f(n) = \left\lfloor \frac{\sqrt{8n+1} - 1}{2} \right\rfloor$$

where [x] means the greatest integer in x. After discovering the pattern (and proving it by mathematical induction), it seemed a good idea to look at the triangular numbers
$x_1 = 1, x_2 = 1 + 2 = 3, x_3 = 1 + 2 + 3 = 6$, etc.
$x_m = [m(m + 1)]/2$
because the rule for defining f(n) fits the same pattern as g(n) = m when n satisfies the inequalities
$[m(m - 1)]/2 < n \leq [m(m + 1)]/2$.
With a bit of algebra, these inequalities define m in terms of n as follows:
$(x - 1)/2 \leq m < (x + 1)/2$, where $x = \sqrt{8n + 1}$.
A bit of fooling around with greatest integers led to the final formula for f(n).

Alan Prince supplied the inductive proof referred to above. He notes first that f(2) = 2, so that the sequence does start off with just one 1. Suppose that the suggested pattern holds up to some N − 1; we show that it holds also for N. Suppose that f(N − 1) is the rth k in the sequence of k's, where $r \leq k$. Notice that by hypothesis the k-run begins with f(N − r). Now, N − f(N − 1) = N − k. If r < k, f(N − k) = k − 1, and f(N) = k. If r = k, then f(N − k) = f(N − r) = k and f(N) = k + 1. Thus, the k-run will have exactly k members, for all k, and is succeeded by the (k + 1)-run.

Also solved by Jacob Bergmann, Alan Unger, Avi Ornstein, Bruce Levy, Charles Sutton, Frank Carbin, George Thomas, Greg Huber, Greg Spradlin, Harry Zaremba, Matthew Fountain, Oren Cheyette, Ray Kinsley, Richard Hess, Robert Bart, Dennis White, Sidney Darlington, Michael Gennert, John Langhaar, Winslow Hartford, P. Michael Jung, Steve Feldman, Alan Prince, Timothy Maloney, Naomi Markovitz, Yale Zussman, Stanley Liu, and Stephan Goldstein.

JUL 4. A spy received a rain-soaked letter. The stamp was gone, and all the postmark was obliterated except two continuous letters, "ON." The contents bore no letterhead, but on decoding the letter the spy concluded it must have been mailed in Bonn, London, or Washington. What is the probability it was mailed in London?

There seem to be two interpretations possible. If one assumes that a certain percentage of the envelope was legible, then London, with two ON's, is twice as likely as either Bonn or Washington to have an ON in the legible portion. In this case the probability that the letter came from London is (by Bayes Theorem)
2x/(2x + x + x) = .5
If, however, one assumes that the rain was a process that managed to leave a random two consecutive letters legible, we must note that the number of possible consecutive pairs in a word is one less than the number of letters in the word. So for London, the chances of the pair being ON are 2/5, and the probability of the letter coming from London is
2/5 ÷ (2/5 + 1/3 + 1/9) = 9/19.
Although this second interpretation gives a better problem, the first seems to match the behavior of rain more closely.

Also solved by Jacob Bergmann, Chip Whiting, Alan Marzilli, Bruce Levy, Frank Carbin, Greg Huber, Greg Spradlin, P. Michael Jung, Harry Zaremba, Ken Rosato, Mary Lindenber Matthew Fountain, Richard Hess, John Langhaar, Peter Wender, Robert Bart, Dennis White, Sidney Shapiro, Winslow Hartford, and Yale Zussman.

JUL 5. I remove one M&M at a time at random from a bag and place it on the table. Whenever there are two of the same color on the table, I eat those two. After I have removed 100 M&M's from the bag, how many might I expect to find left on the table? (Assume there are five colors altogether, distributed equally.) After 101? If brown ones are twice as common as the other colors, how do the expected values change after 100 and 101?

Oren Cheyette, assuming that 100 is large enough to ignore the initial state, gives an easy proof that the answer is 2.4 in all cases. Alan Unger gives us the exact solution. Mr. Cheyette writes:
The following solution assumes an infinite bag of M&Ms (so that successive draws are independent). The expectation value of the number of M&Ms on the table after a large number of draws (whether odd or even) is 5/2 (1/2 for each color) regardless of the relative frequency of each color. The probabilities for a particular number of M&Ms being on the table are, after an even number of draws,
$P_0 = 1/16, P_2 = 10/16, P_4 = 5/16$, all others 0.
and after an odd number of draws
$P_1 = 5/16, P_3 = 10/16, P_5 = 1/16$, all others 0.
After a large number of draws, the M&Ms on the table have "forgotten" the initial conditions (that there were originally none on the table), and then half the time there is one M&M of any given color, half the time there is none. The probability distributions given above may be obtained by looking at the odds for various numbers of heads among five flipped coins, subject to the "parity rule" that there be an even number of M&Ms after an even number of draws, odd after an odd number of draws.

Mr. Unger writes:
Assume there are an infinite number of red, orange, yellow, green, and brown M&Ms in the bag. In the first part of the problem the probability of selecting each color is the same; p = 1/5. Let X(i,j) be a random variable representing the number of M&Ms of color i left on the table after j draws from the bag. By the conditions of the problem there can be either 0 or 1 of each color on the table at any time, and the probabilities of each event are:

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Probability that an even number of M&Ms of color i have been selected after j random draws:
$P(X(i,j) = 0) = Pij$
Probability that an odd number of M&Ms of color i have been selected after k random draws:
$P(X(i,j) = 1) = Qij$
The expected total number of M&Ms remaining on the table after 100 random draws (call this N(100)) is EN(100)
$= E(X(1,100) + X(2,100) + X(3,100) + X(4,100) + X(5,100)$
$= EXC(1,100) + EX(2,100) + EX(3,100) + EX(4,100) + EX(5,100)$
$= 5EX(1,100)$
since the X(i,100) are identically distributed. Now the expected value of X(1,100) is by definition
$EX(1,100) = O\,P(X(1,000)=0) + 1\,P(X(1,100)=1) = O + P(X(1,100)=1) = Q1j = Qj$
Thus, $EN(100) = 5\,Qj$.
The expected number of M&Ms remaining on the table after 100 draws is equal to five times the probability that a particular color has been selected an odd number of times. To compute this probability consider the following recursion relation:
$Qj + 1 = (1 - Qj)p + Qj(1 - p)$.
This is derived by noting that there are two mutually exclusive events that lead to the selection of a particular color an odd number of times after j+1 draws: the color could have been selected an even number of times after j draws, followed by its selection on draw j+1; or it could have been selected an odd number of times after j draws, followed by its non-selection on draw j+1. Adding the probabilities of these events yields the above equation. It is easily solved by using the method of probability generating functions: multiply both sides by x^j, sum from j=0 to ∞, solve for $g(x) = \Sigma\, Q_j x^j$, and equate the coefficient of x^j to Qj. The result is
$Qj = [1 - (1 - 2p)^j]/2$
Thus the expected number of M&Ms remaining on the table after 100 draws is
$EN(100) = 5Q100 = 2.5 - 5(.6)^{100}/2 \approx 2.5 - 1.6 \times 10^{-22}$.
and after 101 draws it is
$EN(101) = 2.5 - 5(.6)^{101}/2 \approx 2.5 - 9.8 \times 10^{-23}$.
In the second half of the problem it is assumed that the probability of selecting a brown M&M is twice as great as the probability for each of the other colors. This implies that the selection probability for browns is 1/3, compared to 1/6 for the other four colors. The equation for the expected value of the number of M&Ms remaining on the table after j draws becomes
$EN(j) = Qj(\text{for brown}) + 4Qj(\text{others})$.
Substituting for Qj yields
$EN(j) = [1-(1/3)^j]/2 + 4\,[1 - (2/3)^j]/2 = 2.5 - (1/3)^j/2 - 4(2/3)^j/2$.
Thus after 100 draws the expected number of M&Ms on the table is
$EN(100) \approx 2.5 - 9.8 \times 10^{-18}$,
and after 101 draws it is
$EN(101) \approx 2.5 - 6.6 \times 10^{-18}$.
Note that the probability is very close to 1/2 that a particular color will be on the table after 100 or 101 draws, whether each color is equiprobable as in the first part of the problem or brown is twice as likely as in the second part. Using the approximation Qj = 1/2, it is easy to derive the distribution of M&Ms on the table after n draws. Given n even, the conditional probability of any combination of colors on the table is 1/16. Since there are five ways to select four colors from five, ten ways to select two colors from five, and one way to select zero colors from five, the probability distribution of M&Ms on the table after 100 draws is as follows:
$P[N(100)=0] = 1/16$
$P[N(100)=2] = 5/8$
$P[N(100)=4] = 5/16$.
By a similar argument the probability distribution after 101 draws is
$P(N[101)=1] = 5/16$
$P(N[101)=3] = 5/8$
$P(N[101)=5] = 1/16$

Also solved by Jacob Bergmann, Henry Lieberman, Ronald Goldman, Chip Whiting, Alan Unger, Frank Carbin, Greg Spradlin, Harry Zaremba, Matthew Fountain, John Langhaar, Oren Cheyette, Dennis White, Peter Kramer, Raymond Kinsley, Richard Hess, Yale Zussman, Robert Bart, Sidney Shapiro, Winslow Hartford, and the proposer, Allen Wiegner.

Better Late Than Never

85 OCT 3. Dennis White has solved several special cases; the general problem remains open.

1986 F/M 4. Stephan Goldstein and Sidney Hendrickson are not happy with the published solution. They also disagree with each other. Mr. Goldstein believes that the original potential energy was .25 mg. Since the final kinetic energy is $.5mv^2$, he concludes that $v^2 = g/2$ or v is approximately 22.14 cm/sec. Mr. Hendrickson writes:

The solution given has two errors. The first is the statement that the wall imparts no energy to the stick. The force the wall exerts on the stick is the horizontal force which causes it to move to the right. F x dx is obviously non-zero. Fortunately, this fact was not used in further analysis of the problem. The basic concept used in this analysis, conservation of energy, is certainly appropriate. The execution was in error, however. Energy lost *is* indeed potential energy and is given by $mg(y_o - Y)/2$, where Y is the height of the end of the stick on the wall. The potential energy *is* converted into kinetic energy. The energy of translation *is* indeed $mV^2/2$. But kinetic energy *is not* just energy of translation. It also includes rotational energy. This had been totally forgotten. The distance of the bottom end of the stick from the wall is given by X. The positions and velocities of the ends are, in (x,y) coordinates, upper end: $(0,Y)$, $(0,-V_y)$, lower end: $(X,0)$, $(V_x,0)$, and the position and velocity of the center-of-mass (COM) are $(X/2,Y/2)$, $(V_x/2,-V_y/2)$. The magnitude of the velocity of the COM is $V = \sqrt{V_x^2 + V_y^2}/2$. With respect to the COM, the stick ends are moving with velocity, upper: $(-V_x/2, V_y/2)$, lower: $(V_x/2, V_y/2)$. A little arithmetic will show that the direction of movement of the ends is perpendicular to the stick as expected, since the stick is rigid and the ends would not move toward (contract) or away from (expand) the center. Some arithmetic will also show that the magnitude of the velocity of the ends with respect to the COM is also V! Hence the angular velocity $w = V/(L/2) = 2V/L$. The energy of rotation is $E_r = w^2I/2 = (4V^2/L^2)(mL^2/12)/2 = mV^2/6$, where I is the moment of inertia of a rod of length L, spinning about its center, and of uniform density with mass m.

As with the previous analysis, lost potential energy is equated with kinetic energy gained: $Mg(Y_o - Y)/2 = E_t + E_r = 2mV^2/3$, but this time the kinetic energy contains the rotational energy term. As with the previous analysis, $2V^2 = (V_x/Y)^2$; hence $V_x = \sqrt{3/4}\,Y\sqrt{g(Y_o - Y)}$. This is $\sqrt{3/4}$ of the final expression found previously. A similar analysis to previous $dV_x/dt = 0$ when $Y = 2Y_o/3$, exactly at the same point as before! (My Y_o is the original height of the upper end of the stick, 50 cm, so Y = 100/3.) The difference is that V_x is $\sqrt{3/4}$ of the value found previously, or approximately, 32.0 cm/sec.

JUL SD2. Although I normally do not print comments on speed problems, I could not resist the following remark from Charlie Bostick:
I usually ask this question about analog watches and then, when the solution is exposed, ask if there is a corresponding algorithm for digital watches. Yes, there is! One notes the time on the digital watch and mentally pictures the hands as they would appear on the analog watch. Then the same rule is followed. If digital watches ever completely replace analog watches, then people may never be able to picture the hands mentally. At that time in the future, unless compasses are used, people will have the time but not the inclination.

Proposer's Solutions to Speed Problems

SD 1. The ratio of the areas of the inscribed to circumscribed circles.

SD 2. $2^{1.23}$.





tially dangerous water.

Developing countries generally charge about the same for domestic water as developed nations. For example, in 1978 water in Surabaya, Indonesia, cost an average of $1 per 1,000 gallons—about the average U.S. price. The effect is that water charges take a bigger bite out of family budgets in Indonesia and other developing countries, because they have more poor residents. Gilbert White of the University of Colorado found that middle-income workers in Nairobi spend as much as 8 percent of their income on water—more than they spend on fuel, transport, or household furniture and appliances. Therefore encouraging water conservation by increasing prices for household supplies could be very regressive in developing countries. Since domestic use accounts for only a small percentage of total water consumption, an exception should be made for the poor. What's more, residents of Third World countries need to consume more, rather than less, water from good supplies to improve their health.

Water Supplies and Health

Some 86 percent of the world's rural population—more than 2 billion people—lacks an adequate supply of clean water, while 92 percent lacks adequate facilities for waste disposal. A wide variety of diseases, from cholera and typhoid to guinea worm, threatens these people.

Ironically, some of the major water projects built in the past century have spread diseases. The classic case is the increase in schistosomiasis in Egypt that resulted when the Aswan Dam was built in the 1960s for irrigation water. This debilitating disease, which currently infects more than 200 million people worldwide, is carried by a snail that lives along the banks of reservoirs or in canals with slow-moving water. Schistosomiasis worms hatch in humans after larvae enter blood vessels through the skin.

To combat water- and wastewater-related diseases, the United Nations has set 1980 to 1990 as the International Drinking Water Supply and Sanitation Decade. The objective is to ensure "clean drinking water and sanitation for all." This goal is too ambitious to be reached by the end of the decade, but it could be achieved by the turn of the century.

Whether the goal can be met depends on how much money the world is willing to put forward. The World Health Organization estimated in 1984 that it would cost $22 billion per year in capital investments—or $10 billion more per year than the Third World countries now spend on water and wastewater facilities—to supply a latrine and an outdoor standpipe for every few households, and to collect excrement nightly. (That's the level of water-supply and sanitation facilities in Bombay.)

The World Bank estimates that supplying indoor plumbing and water-based flush toilets in regions without them would cost $350 billion to $650 billion in capital investments. That would represent an annual cost of $150 to $650 per household, includ-

ing interest payments and operation and maintenance fees. The price would depend on local circumstances such as population density and topography. Needless to say, those prices would be a very large fraction of total family income in developing nations, and it seems doubtful that consumers could afford to spend so much.

The less costly project—supplying latrines and standpipes—is more realistic, but it is unlikely that international funding agencies will be willing to provide the additional funds even for these efforts, given the Third World debt situation. Instead, these countries will have to rely on domestic banks and local contractors and suppliers, and they will have to make this goal a priority. Unfortunately, even though public health is vital to economic development, most politicians would rather spend the money on military hardware.

Yet despite the diseases associated with poor water sources and sanitation, some of the world's poorest nations should first invest in other projects that generate income more directly. True, many health professionals believe that the benefits of clean water supplies relate directly to the size of the investment. They point to the significant improvements in public health that coincided with the widespread introduction of clean water and sanitation facilities in the industrialized countries. But Hillel Shuval of the Technion Israel Institute of Technology maintains that the potential health benefits from such projects partly depend on a population's income, education, class structure, and initial health. This suggests that public health in very poor countries can be little improved by investing only in community water supplies and disposal facilities. Programs to improve nutrition, education, and primary health care must accompany the water and sanitation efforts. Most countries sponsor these other programs, but it is difficult to integrate them with schemes to improve water quality because they are managed by different agencies.

Furthermore, a program focusing on just one goal, such as providing safe drinking water but not sanitation facilities, may not reduce people's exposure to infection sources enough to be worthwhile. In Bangladesh, for example, more than 100,000 wells were dug during the 1960s and 1970s to protect village water supplies, but there was no sanitation program to provide latrines and training in hygiene. The project did not lead to commensurate improvements in people's health.

Given this situation, many of the poorest countries should probably invest in industry, transportation, and other projects before water programs. If they disperse their money too widely—even into projects of great social worth—these countries cannot generate enough income to pay back their loans and to borrow more for added development. Such a policy may not be attractive politically, but it makes sense. This does not mean that these countries cannot accomplish a great deal by continuing programs such as building latrines in some areas. But nations should steer clear of massively redirecting their domestic policies and undertaking large-scale engineering systems until they can afford them. It is countries such as Thailand, Malaysia, the Philippines, Indonesia, and Kenya that are a step above the very poor that would probably benefit most from investing in capital-intensive water-supply facilities and wastewater treatment plants.

While many developing nations have inadequate water supplies, industrialized countries face a loss of water supplies from chemical contamination. Governments should act as swiftly as possible to stop water pollution from agricultural and industrial by-products, some of which have no previous independent existence in the natural environment. Treating contaminated water is much more costly.

In fact, because of the cost, it's not realistic to treat all contaminated water. Municipalities should clean only the water needed for personal consumption, since the costs are small compared with the water's real value. For example, the use of granulated activated charcoal to purify water, a method that works well for most toxic chemicals and has become popular in Europe, would increase water costs in U.S. communities between 20 and 40 percent. Such increases would raise domestic water rates to less than half those paid by consumers in comparable European cities. After all, in 1983 the citizens of Boston paid $1 per 1,000 gallons of water, while the residents of Frankfurt, Germany, paid $2.82.

What Should Be Done

Just because we have not managed water supplies in the most appropriate ways so far does not mean that we cannot adjust. Nations should set up small, cabinet-level authorities responsible for reviewing, for-

Some poor countries should rely on small-scale irrigation techniques rather than large, expensive dams.



mulating, and coordinating water policy, with the power to force other agencies to implement the policy. These authorities are needed to promote the broader public's welfare over the political influence of powerful alliances—the so-called "iron triangles" consisting of particular water users, agencies, and legislators.

The central authorities should thoroughly analyze all water uses and supplies so the overall economic picture becomes clear. They also should require water agencies to base the price of water on the costs of supplying and treating it using their newest facilities, and to include a charge for the water itself. And each utility should have to charge all water users except poor households the same price.

In countries that promote a free-market system, users should be allowed to sell and buy water rights freely. For example, farmers near Phoenix should be allowed to sell to the city's water utility their rights to buy irrigation water from the Salt River project.

Many people argue that we can solve our water problems partly by avoiding large supply projects, since smaller developments have fewer environmental effects and tend to be more economical. Yet large projects can sometimes be made economical and their environmental impacts can be minimized through careful planning and design. The snails that harbor schistosomiasis in the Aswan Dam would not survive if water flowed through the irrigation channels more quickly or the water level was changed regularly, for example. We should avoid knee-jerk negative reactions to large projects just because they are big.

As an alternative to building large dams, water can be stored underground in the soil and pumped up as needed. To infiltrate the water into the ground, it may be necessary to scour dry riverbeds occasionally so that they will absorb floodwater, or to dredge channels so that floodwater will be diverted into gravel pits and other pervious areas. Not only do underground reservoirs cost two-thirds as much as reservoirs and dams built above ground, but they prevent the loss of water through evaporation. They do not create habitats that can spread water-related diseases, and people do not have to be displaced from their homes. An underground reservoir's main environmental impact is to decrease the nutrients that runoff would normally deliver to the ocean. An underground storage scheme is now being used to supply some of the water to Los Angeles and is the reason the once "mighty Santa Ana" River—which used to run during flashfloods—is always dry now.

The water problems that the world faces are not unexpected, given the common perception of water as a free and unlimited resource. It is a great temptation to believe that the problems have been caused by others, but each individual needs to appreciate water's real economic value. Only then will we use water differently and avoid serious shortages and the human suffering they entail. □



The Fairness Doctrine Is Shackling Broadcast

BY HUGH CARTER DONAHUE

TELEVISION and radio inform us about the pressing issues we face: the deficit, the arms race, the homeless, the shift from manufacturing to service, the latest political scandals, South Africa's deepening chaos, drunken drivers, and insider trading on Wall Street, to name a few. The list goes on, almost as 24-hour all-news programming does. Every weekday night 38 million Americans watch one of the network newscasts, and 4 million watch public television's "MacNeil/Lehrer Newshour." The Cable News Network reaches 700,000 viewers with around-the-clock service daily, while 80 percent of all Americans listen to the news over their radios.

For nearly 200 years the First Amendment of the Bill of Rights has protected speech from government censorship. The amendment states simply that "Congress shall make no law respecting an establishment of religion, or prohibiting the free expression thereof; or abridging the freedom of speech, or the press; or the right of people peaceably to assemble, and to petition the Government for a redress of grievances."

Of course, laws and court decisions do place some limitations on speech. One may not libel another individual with impunity or cry "Fire!" in a crowded theater where there is no fire. But in general a person may voice any opinion, no matter how seemingly outrageous, and allege any fact, no matter how universally disputed. Those who framed the Constitution believed that as long as government was prohibited from censorship, diverse voices would present a variety of views to the public.

However, special rules apply for television and radio news broadcasts, as well as for public-affairs programs, which provide analysis or in-depth coverage of timely public issues. Since 1949 the Federal Communications Commission (FCC) has regulated these forms of speech through the Fairness Doctrine, which imposes two requirements. First, broadcasters must air controversial news and public-affairs programming. If viewers or listeners believe programming is not fair, they can petition the FCC to instruct broadcasters to cover stories and issues differently. Second, the Fairness Doctrine demands that broadcasters give organizations and individuals airtime to respond to editorials and to commercials

ILLUSTRATION: ROB COLVIN

Diverse new channels and communications technologies make the government's practice of regulating broadcast for "fairness" obsolete.





on public issues. If a broadcaster sells time to advocates of a balanced budget, opponents of a balanced budget must receive time, too. And if none of them will pay for that time, the broadcaster must donate it. Comparable regulation for print would be unthinkable.

The Fairness Doctrine rests on the technological grounds of "spectrum scarcity." The number of radio and television channels is limited, since each has to have exclusive use of a certain amount of bandwidth—a certain range of frequencies—within the portion of the electromagnetic spectrum suitable for broadcast.

The rationale is that there are more people who wish to operate television and radio stations than there are available channels. So the broadcaster becomes a public trustee with a government license to use a scarce resource. Members of the community cannot simply start stations to broadcast their own views, as they might presumably start a small newspaper. Instead, the Fairness Doctrine requires each broadcaster to provide access to individuals and organizations. The audience is sovereign of the airwaves, and the government measures the diversity of speech by looking at the individual broadcaster, not the sum of all broadcasters.

Despite its apparently beneficent purposes, the Fairness Doctrine is Orwellian. This novel inversion of First Amendment rights shifts protection from speakers—radio and television broadcasters—to listeners. It does not seek to prevent government censorship. Rather, the overriding concern is to ensure that people are exposed to divergent viewpoints. While the First Amendment keeps the government out of the business of regulating speech, the effect of the Fairness Doctrine is to put the government squarely in that business.

The results are predictable. Interest groups can push their agendas, and administrations can threaten to revoke licenses if they dislike coverage. According to Floyd Abrams, a prominent First Amendment attorney and NBC's lawyer, administrations going back to Kennedy have attempted to exert pressure on broadcasters through the FCC. He charges that in 1984 and 1985 the CIA attempted to use the Fairness Doctrine to challenge ABC's coverage of an alleged CIA plot to assassinate a former agent.

Though designed to increase the variety of views aired, the Fairness Doctrine in practice achieves the opposite effect. Producers become timorous, reluctant to face conflicting demands for reply time and government complaints about fairness violations. FCC Commissioner James H. Quello, who opposes the Fairness Doctrine, has described an incident that occurred when he was general manager of WJAR Radio in Detroit. In 1960 his station ran editorials in favor of fluoridation but granted an anti-fluoridation advocate a chance to voice a rebuttal. Medical and dental experts lodged a sheaf of criticisms, saying that the station had confused the public, and Quello had to agree. The station ended up dropping editorializing entirely to avoid Fairness Doctrine controversies.

When there were few radio and TV stations, and their ownership was concentrated in large corporations, it may have appeared reasonable to require community access to broadcast technology, despite all the problems that approach entails. However, the number of television and radio stations has increased enormously, and cable television, satellite broadcasts, low-power television, and other new communications technologies have proliferated. More and more producers can provide a wide range of radio and television news programs. It is time to give broadcasting the same First Amendment rights that the print media enjoy.

HUGH CARTER DONAHUE is assistant professor of journalism at Ohio State University. He earned his Ph.D. in communications and policy analysis from M.I.T. and worked as a newswriter at WNEV-TV in Boston.





Fairness Doctrine supporters are strange bedfellows. Opposite page: Labor (left) sides with Phyllis Schlafly (right), an opponent of the Equal Rights Amendment. This page: Anti-nuclear advocates (left) have used the doctrine to suppress utility ads, and the National Rifle Association (right) believes it helps in communicating the case against gun control.

The Political Controversy

Interest groups that battle each other on virtually all other issues close ranks behind the Fairness Doctrine. Supporters include big business such as General Motors and Mobil; Phyllis Schlafly's right-wing Eagle Forum; Accuracy in Media, a group committed to ending journalism's allegedly liberal bias; the National Rifle Association; labor organizations; the Anti-Defamation League of B'nai B'rith; the NAACP; and the Democratic Party.

All contend that the Fairness Doctrine is not excessively intrusive. They believe it is merely remedial, allowing imbalances in news coverage to be corrected and granting interested individuals and organizations an opportunity to respond to editorial views. To be sure, broadcasters live with the threat of losing lucrative licenses should they fail to comply. But Fairness Doctrine proponents point out that between 1980 and 1986, when over 132 cases of unfairness were alleged, the FCC ruled against only 20 broadcasters. The commission dismissed many more cases as unworthy of review.

The proponents use the Fairness Doctrine to advance their particular causes. Phyllis Schlafly, who opposes the Equal Rights Amendment (ERA), claims that the Fairness Doctrine gives her the power to arrange for negative news coverage of this issue. "Of all the TV coverage on the ERA, over 95 percent was pro-ERA and only 5 percent of it was against the ERA. If it weren't for the Fairness Doctrine, we couldn't have gotten even that measly 5 percent," she said in 1985, during hearings the FCC conducted on the Fairness Doctrine. At the same hearings, a B'nai B'rith attorney claimed that the Fairness Doctrine helps fight anti-Semitism in small towns with few radio and no television stations. But then he clumsily acknowledged that B'nai B'rith had used the Fairness Doctrine to negotiate network coverage of the 1982 Israeli invasion of Lebanon.

Mobil praised the Fairness Doctrine for enabling it to go after broadcasters whose news reports of the giant oil company have been critical. That freedom is important to Mobil since many broadcasters refuse to carry its public-message commercials. They do so not out of any special love for the little guy but because the Fairness Doctrine obligates them to air opposing public-interest advertisements even if no one will pay for the time. Anti-nuclear advocates suppressed ads for a New York power plant by bringing a Fairness Doctrine complaint to the FCC.

Some might ask why TV stations shouldn't provide forums for interest groups. Aren't the groups using the doctrine just as it was intended? However questionable some of the viewpoints might seem, doesn't the flow of information to the public stimulate debate?

Of course, television should provide interesting, informative programming. But in an era of many sources of news and information, how sensible is it to require each TV station to balance its news and public affairs shows? Should individual broadcasters have to bend news programming to accommodate specific interests? Wouldn't more intelligent policy give broadcasters the same First Amendment rights as print journalists? Broadcasters already worry lest their news programming offend their audience and jeopardize advertising revenues. The Fairness Doctrine merely aggravates the problem. Broadcasters purvey the uncontroversial to forestall the relentless stream of interest-group demands.

Broadcasters, journalists, and broadcasting trade groups say that the Fairness Doctrine chills news coverage, stifles controversial public-affairs programming, and inhibits editorials. CBS anchor Dan Rather commented for the 1985 FCC inquiry, "When I was a young reporter, I worked briefly for the wire services, small radio stations, and newspapers, and I finally settled into a job at a large radio station owned by the *Houston Chronicle*. Almost

PHOTOS: AP/WIDEWORLD; ELLIS HERWIG, LIONEL DELEVINGNE, PATRICIA GROSS/STOCK BOSTON

Communities invariably have more television and radio stations than newspapers. Why regulate broadcast news and not print?

immediately on starting work in that station's newsroom, I became aware of a concern which I had previously barely known existed—the FCC. The journalists at the *Chronicle* did not worry about it; those at the radio station did. Not only the station manager but the newspeople as well were very much aware of this government presence looking over their shoulders. I can recall newsroom conversations about what the FCC implications of broadcasting a particular story would be. Once a newsperson has to stop and consider what a government agency will think of something he or she wants to put on the air, an invaluable element of freedom has been lost."

Bill Monroe, former moderator of NBC's Meet the Press, said that news directors of major networks shun controversial stories for fear they will have to document their decision making to the FCC. This time-consuming task involves compiling supporting and countervailing evidence, assembling scripts, and collecting news-show formats, which tell when stories appear and how long they run. Smaller broadcasters, particularly those in radio, say that the costs of fighting a fairness complaint can lead to bankruptcy. "Broadcasters will acquiesce [to interest groups] to stay out of trouble even if they don't have to," noted Harriet Kaplan, a past president of the National Radio Broadcasters Assn. and licensee of two radio stations in Charlotte, N.C.

The Fairness Doctrine also permits government officials to meddle in television news. The Reagan White House remarks more routinely on the fairness than the accuracy of television news about defense, hunger, tax legislation, and the misadventures of administration appointees forced from their jobs. On 21 occasions at the height of anti-war demonstrations in October 1969, President Nixon ordered his staff to take "specific action relating to what could be considered unfair news coverage." Nixon cowed the networks so successfully that they did not interrupt coverage of weekend football to show massive anti-war demonstrations in the nation's capital.

Technological Abundance

While evidence against the Fairness Doctrine mounts, the strongest rationale for it—spectrum scarcity—is technologically obsolete. Numbers alone tell much of the story. Today the country has over twenty times as many television stations and nearly four times as many radio stations as in 1949 when the Fairness Doctrine was formulated. In 1949 there were only 51 standard (VHF) commercial television stations. By 1985 there were 541 commercial and 113 public VHF stations. Ultra-high-frequency (UHF) broadcasting didn't even exist in 1949, yet 369 commercial and 185 public stations had sprung up by 1986. The number of AM and FM radio stations rose from 2,564 in 1949 to 9,766 in 1985. Nearly three-quarters of all Americans who owned televisions in 1966 received six or fewer stations, but by 1984 nearly two-thirds could watch more than nine. Some had access to more than twenty.

Fairness Doctrine advocates argue that national figures on radio and television stations are misleading because they do not indicate how many channels individual communities receive. But communities invariably have more television and radio stations than they have newspapers. For example, Los Angeles, the second largest broadcast market in the country, supports ninety-five radio and television stations and three daily newspapers. Pittsburgh, the twelfth largest television market, sustains eighty-two radio and television stations and two daily newspapers. Sixty-seven radio and television stations provide Hartford, Conn., the twenty-second TV market, with news, as does only one daily paper. Residents of Austin, Tex., tune in to fifty-one radio and television stations and read one daily newspaper.

As the number of television stations has increased, the time devoted to news programming has expanded. In 1983 regularly scheduled network television news accounted for 60.5 hours of TV programming per week. That's two-and-a-half times as much as the 24 hours per week in 1981, and nearly four times as much as the 16 hours in the late 1960s. Local television stations have also boosted their news programming, though not as dramatically as the networks. By 1982 locally produced news programming took up 10 hours of airtime per week, compared with 8 in 1971.

Independently owned television stations have become common. By the mid-1980s, there were 227, up from 77 in 1970 and 30 in 1960. Those stations were offering more local news, too: eight hours a week, up from three hours in 1974.

Cable television, video cassette recorders (VCRs), and an alphabet soup of other communications technologies are further widening the choices available to Americans who watch television. A.C. Neilson Co. estimates that in 1985 over 38 million American



households, or 43 percent of those with TV, subscribed to cable. Some 6,600 cable systems were operating in 18,500 communities, and approximately 1,600 franchises were scheduled to be built. The cable industry anticipates robust growth to a total of 48 million to 60 million subscribers by 1990. Cable provides extensive news and public-affairs programming, including the Cable News Network, the Financial News Network, and C-Span, which gives live coverage of the U.S. Senate and House.

VCRs let viewers have flexibility and options. While it is safe to assume that VCRs are used mostly for entertainment, people do record news and public-affairs programs that they would otherwise miss, and they can view documentaries and movies that are not on television. By 1985, over 23 million U.S. households had VCRs, and the total is projected to exceed 67 million by 1990. Approximately a million VCRs are sold every month.

Direct broadcast satellites use several microwave bands to transmit programming straight to television sets. Satellite receiving dishes dot the roofs of neighborhood taverns in urban areas, as well as the backyards of homes in many rural areas not served by cable. In 1985, a million such earth stations were in use in the United States, and their numbers were expected to grow by 40,000 to 80,000 per month. Admittedly, satellite dishes enable viewers to watch more sports and entertainment, not just more news. But the point is that citizens enjoy choices they never had in the past. Broadcasting is no longer monopolized by a few stations.

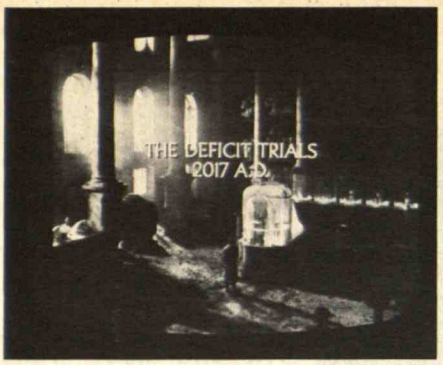
Many individuals, religious organizations, and small corporations run low-power television (LPTV) stations, which are limited to 10 watts for VHF and 1,000 watts for UHF. In 1982 the FCC authorized these stations to produce programming. (Until then, most of them relayed other broadcasters' signals.) By 1985, 126 low-power UHF and 215 low-power VHF stations had been licensed. The FCC projects that 4,000 will eventually come on line with shows tailored to their audiences. In rural communities this may mean more news on agricultural issues, while in cities it may mean a focus on specific ethnic groups. And since the FCC is issuing LPTV licenses in areas without many broadcasters, programming diversity could increase even more in the least diverse markets.

Multipoint distribution service (MDS), an innovative technology using microwave transmission, provides programming to which citizens subscribe much as they would to cable. By 1985, the FCC had received more than 16,000 applications for MDS licenses. Satellite master antenna television systems (SMATV) are "private" cable operations that allow subscribers in apartment and condominium complexes, hotels, and trailer parks to pull in channels from satellites. SMATV is popular in both urban and rural areas not served by cable, but of the newer technologies, it has been the least successful in finding a market niche.

Proponents of the Fairness Doctrine contend that the impact of these technologies will be felt only in the distant future. This argument is easily refuted by a visit to the video rental store in a suburban shopping mall or a search of the urban and rural horizon for satellite dishes.

Proponents also contend that the doctrine remains

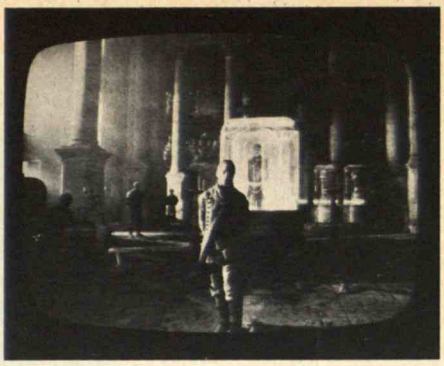
ILLUSTRATION: ROB COLVIN



The Federal Deficit Trials, 2017 AD



The next generation accuses . . .



former political leaders . . .

necessary because spectrum scarcity is *sui generis* to broadcasting. But existing spectrum goes unused in some markets. Furthermore, today's television sets are capable of receiving far more signals than the first sets in the late 1940s and early 1950s.

Finally, those who favor the Fairness Doctrine point to the high prices stations command in large markets. In 1985, a banner year for broadcasting sales, the FCC approved 99 television-station sales and over 1,500 radio-stations sales exceeding $8 billion. In Boston, the nation's sixth market, WCVB (channel 5) sold for $450 million. The argument is that such high figures, which reflect the economic barriers to entering the market, are sufficient grounds to impose fairness obligations on broadcasters. However, markets the size of Boston's are immensely competitive. Each station struggles to outdo the others in bringing news to viewers. Admittedly, they often seem indistinguishable as they cover identical stories. But so do many news organizations, frequently including newspapers, and that is never seen as a reason to deprive them of First Amendment rights.

The Powerful Weapon of Broadcast

The history of the Fairness Doctrine helps explain its remarkable durability. The doctrine stemmed from fears that too much media power would be concentrated in too few hands. During the 1920s, fewer than 600 radio stations broadcast to the American people. Many feared that unless giant broadcasting companies such as RCA were restrained by federal law, they would influence election results and dominate public opinion. Debating the Radio Act of 1927, a milestone in U.S. communications law, Rep. Luther H. Johnson (D-Tex.) warned the U.S. House, "Publicity is the most powerful weapon that can be wielded in a republic, and when . . . a single selfish group is permitted to . . . acquire ownership and dominate these broadcasting stations throughout the country, then woe to those who dare to differ with them. It will be impossible to compete with them in reaching the ears of the American people."

When Congress passed the Radio Act in 1927, it imposed general obligations on radio broadcasters to serve the "public interest" and grant political candidates "equal opportunities" to use the airwaves. The public-interest responsibilities became the basis for the Fairness Doctrine, while those concerned with equal opportunities quickly became known as Equal Time. Today, Equal Time requires that if broadcasters sell or donate time to one candidate, they must sell or donate time on the same basis to all legally qualified candidates. Broadcasters do retain discretion: if they refuse one candidate time, they can refuse all.

In both the Radio Act and the Communications Act of 1934, Congress imposed Equal Time only on advertisements by candidates, not on news and public-affairs programming. Entertainment dominated radio in those days, so no extra regulation was justifiable. More significantly, Congress worried about opening the door to censorship. In House debate of the Radio Act, Fiorello LaGuardia, then the representative from New York's polyglot East Side, pushed for stringent guarantees of broadcasters' free-speech rights. Rep. Wallace H. White (R-Maine), architect of the Radio Act, assured LaGuardia that the Radio Act protected free speech: "The pending bill gives . . . no power of interfering with freedom of speech in any degree." LaGuardia pressed him: "It is the belief of the gentleman and the intent of Congress not to exercise . . . any power whatever [that would interfere with freedom of speech] in considering a license or the revocation of a license." Again White assured him, "No power at all."

However, by making a broadcast license contingent on serving the public interest, Congress opened a Pandora's box of First Amendment law. The stage was set for Fairness Doctrine regulation of radio and television news and public-affairs programming.

Throughout the late 1920s and the 1930s, the Federal Radio Commission (FRC) and its successor, the FCC, relied on broadcasters' public-interest responsibilities to elaborate the concept of listener rights, or listener sovereignty. The FRC and FCC





In this public-message commercial for W.R. Grace and Co., a group of children brings its elders to trial for failing to check the growth of federal budget deficits. When the company tried to buy prime-time spots for the commercial last year, the major networks refused, saying that the ad was "controversial." Under the Fairness Doctrine, broadcasters must provide equal air time for groups to respond to controversial statements even if they can't pay for it.

of runaway deficits.

ruled that because there were so few radio stations and so many listeners, stations had to broadcast something for everybody. Stations that broadcast programs targeted at specific audiences such as labor or religious groups were denied license renewals.

In its famous Mayflower Decision of 1941, the FCC went a step further. It prohibited radio-station owners from editorializing. This was supposed to prevent them from promoting political favorites and endorsing preferred legislation. "A truly free radio cannot be used to advocate the causes of the licensee. . . . It cannot be devoted to support the candidacies of his friends. It cannot be devoted to support the principles [the broadcaster] happens to regard most favorably. In brief, the broadcaster cannot be an advocate," the FCC ruled. As in the 1920s and 1930s, the FCC reasoned that the rights of listeners superceded those of broadcasters.

By 1949, the FCC realized that the Mayflower Decision's censorship vitiated the public interest, and the commissioners voted to restore radio-station owners' rights to broadcast editorials. But at the same time they passed the Fairness Doctrine. Only four of seven commissioners voted for it, and two did so reservedly. One of these two, Commissioner Robert F. Jones, said it was an improvement over the Mayflower ban, but he blasted his fellow commissioners for requiring broadcasters to think ahead about who would be knocking on the station door to demand reply time to editorials. In his opinion, such a requirement constituted a prior restraint on broadcasters' free-speech rights. The other commissioner with misgivings, E. M. Webster, cautioned that the vagueness of the Fairness Doctrine would cause problems in implementation. Webster thought the doctrine's tone as an "academic legal treatise" was too removed from day-to-day news operations and editorial decision making.

Commissioner Frieda Hennock, who dissented, stated that "the standard of fairness" would be "virtually impossible" to enforce: "We should not underestimate the difficulties inherent in the discovery of unfair presentation in any particular situation, or the problem presented by the fact that the sole sanction the commission possesses is total deprivation of broadcast privileges in a renewal or revocation proceeding which may occur long after the violation."

The Shifts of First Amendment Law

In 1969, well after television had become commonplace in American living rooms, the Supreme Court upheld the constitutionality of the Fairness Doctrine. The case concerned a small, fundamentalist radio station, Red Lion Broadcasting Co. It had aired an attack on liberal columnist Fred Cook by right-winger Billy Jean Hargis and had failed to grant reply time to Cook. Sounding the listener-sovereignty theme, Justice Byron White wrote that "it is the right of the viewers and listeners, not the right of broadcasters, which is paramount. There is nothing in the First Amendment which prevents the government from requiring a licensee to share his frequency with others and to conduct himself as a proxy or fiduciary with obligations to present those views and voices which are representative of his community and which would otherwise, by necessity, be barred from the airwaves." Ideally, the Court observed, broadcasters should enjoy the same First Amendment rights as newspapers, but the technological limits on spectrum and the superior claim of citizens to see and hear news preclude such rights. The Court ruled that it would reconsider the constitutionality of the Fairness Doctrine if it was shown to stifle rather than promote news and public-affairs programming.

The *Red Lion* decision was the high-water mark of listener sovereignty. In subsequent decisions, the Court began to rule in favor of greater First Amendment freedoms for broadcasters. For example, in 1973 in *Columbia Broadcasting System v. the Democratic National Committee,* the Court upheld the rights of broadcasters to refuse paid editorial advertisements. The Court rejected the view that "every potential speaker is the 'best judge' of what the listening public ought to hear." Quite the contrary, the ruling stated that "for better or worse, editing is what editors are for; and editing is selection and choice of material. That editors—newspapers or

PHOTOS: W.R. GRACE

"The Fairness Doctrine enables administration after administration to toy with TV or radio to serve its sordid or benevolent ends."
—Justice William O. Douglas

broadcast—can and do abuse this power is beyond doubt, but that is no reason to deny the [editorial] discretion Congress provided. Calculated risks of abuse are taken in order to preserve higher values."

In language that recalled Commissioner Jones's reservations about the Fairness Doctrine, the Court disapproved any role that would draw the FCC into a "continuing case-by-case determination of who should be heard and when." The Court did not want to require the FCC to "oversee far more of the day-to-day operations of broadcasters' conduct, deciding such questions as whether a particular individual or group has had sufficient opportunity to present its viewpoint and whether a particular viewpoint has already been sufficiently aired."

Justice Potter Stewart affirmed that the First Amendment guarantees freedom "from the intrusive thumb of government." The founders of this country believed that "fairness was far too fragile to be left for a government bureaucracy to accomplish," Stewart maintained. "If we must choose whether editorial decisions are to be made in the free judgement of individual broadcasters, or imposed by bureaucratic fiat, the choice must be for freedom." Justice William O. Douglas wrote, "My conclusion is that television and radio stand in the same protected position under the First Amendment as do newspapers and magazines. . . The Fairness Doctrine has no place in our First Amendment regime. It puts the head of the camel inside the tent and enables administration after administration to toy with TV or radio in order to serve its sordid or benevolent ends."

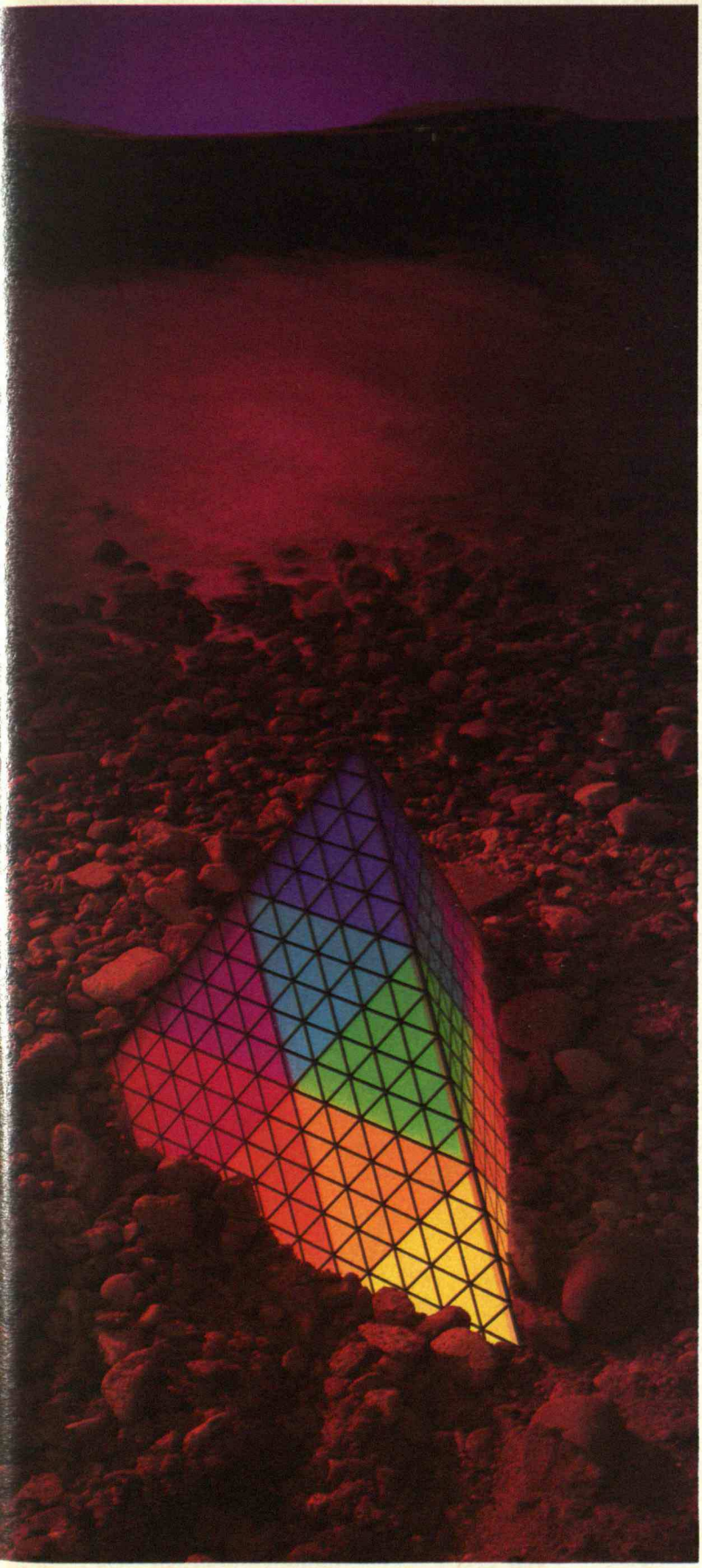
More recently, the Court is signaling its willingness to reconsider the constitutionality of the Fairness Doctrine. A 1984 case, *Federal Communications Commission v. League of Women Voters of California,* lifted a long-standing rule that prohibited public television stations from editorializing. The rule had grown out of fears that the federal government would use the stations as propaganda outlets. Such regulation stifled news and public-affairs programming, the Court declared. And in making that declaration, it gave the green light to future review of the Fairness Doctrine: "As we recognized in *Red Lion* . . . were it shown by the commission that the Fairness Doctrine 'has the effect of reducing rather than enhancing' speech, we would then be forced to reconsider that constitutional basis of our decision in that case."

In its 1985 inquiry, the FCC found that the Fairness Doctrine inhibits rather than promotes presentation of controversial public issues. The commission also recognized that new technologies are significantly expanding the number of available channels. It concluded that the Fairness Doctrine disserves the public interest.

However, the FCC maintained that it could not do anything to eliminate the doctrine because of a regulatory and legal morass. Fairness Doctrine supporters insist that Congress made the doctrine federal law in 1959 with Equal Time amendments that reaffirm fairness obligations "to provide reasonable opportunities for the discussion of conflicting views on issues of public importance." Opponents contend that Congress only inserted such language into the 1959 amendments so as not to interfere with the FCC's enforcement of the Fairness Doctrine. The Radio and Television News Directors Association has petitioned the U.S. Court of Appeals to force the FCC to do away with the Fairness Doctrine. Fairness Doctrine proponents have filed counter petitions.

A good case can be made that in passing the 1959 amendments, Congress did not mean to codify the Fairness Doctrine as law. The amendments responded to an FCC decision based on Equal Time requiring broadcasters to provide time to all candidates if they ran news stories on any candidate. Congress feared that radio and TV stations would freeze out all political news to avoid numerous demands from candidates for air time, and in particular that the major networks would black out the 1960 Democratic and Republican conventions. Congress amended Equal Time to avert this eventuality. It tacked on the sentence about the Fairness Doctrine not to codify it as law, but merely to ensure that the amendments did not interfere with it.

This view is supported by a recent U.S. Appeals Court case exempting teletext (which transmits print and graphics over the air and promises to be widely used for newspaper articles) from the Fairness Doctrine. In *Telecommunications Research and Action Center and Media Access Project v. Federal Communications Commission,* the court ruled that the Fairness Doctrine "was an administrative construction, not a binding statutory directive." Thus, an accurate reading of congressional intent would enable the FCC to repeal the Fairness Doctrine. The FCC should have the courage of its convictions and do this, finally granting full First Amendment rights to broadcast journalism. □



What Age Is Next?

The ages of man are told by the materials he masters—and by the technologies these materials make possible:

The old stone age and the new—paleolithic and neolithic—the iron age and the bronze age.

The industrial society, the atomic age, the space age... the age of electronics? The information society?

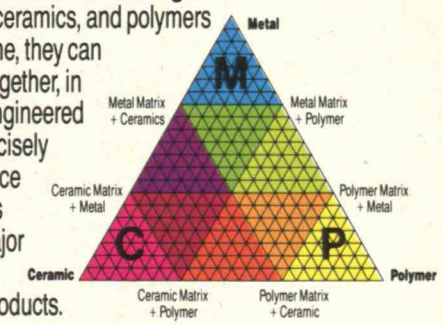
What age *is* this?
What age is next?

On every hand, technologies are straining at the limits of present day materials. Monolithic materials like steel, aluminum, and ceramics can still be coaxed to higher levels of performance. We're actively pursuing some promising developments right now.

But beyond that, the time is at hand for a whole new generation of materials. A new age.

The Engineered Materials Age.

What metals, ceramics, and polymers cannot do alone, they can probably do together, in composites engineered to achieve precisely the performance characteristics needed for major advances in engineered products.



That's what we're working on at Alcoa Laboratories. We're out to make a material difference, and our progress is accelerating.

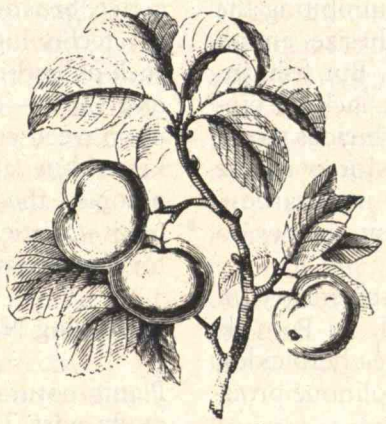
For a closer look at what we're doing, send for our book, *The Material Difference.* Write to Dr. Peter R. Bridenbaugh, Vice President—Research & Development, Box One, Alcoa Laboratories, Alcoa Center, PA 15069.

ALCOA



We can reduce our dependence on cancer-causing herbicides by breeding crops that resist more benign compounds.

Engineering Crops to Resist Herbicides



In the past 30 years, the use of chemical herbicides has become established agricultural practice in developed countries. Today more than 95 percent of the acreage devoted to most major field crops is treated with at least one and often two to five herbicides annually. Two or more products are generally needed to control grass and broadleaf weeds. In many cases one herbicide controls weeds that germinate in early spring, while others control later-sprouting weeds.

By eliminating weeds that compete with crops for nutrients and water, herbicides have helped farmers substantially raise their profitable yields. Plant breeders have produced varieties that can be cultivated much more densely. It is now common for farmers to plant 24,000 corn seeds per acre, in contrast to 14,000 before the advent of herbicides and synthetic fertilizers.

But herbicide use requires major cash outlays. For many field crops, farmers now spend about as much on herbicides as on seed. In this era of poor farming returns, every component of production costs is under continuous scrutiny.

The economics of weed control is not the only herbicide-related concern in farm country. Mounting evidence indicates that herbicides can cause serious public-health problems and environmental damage. In the last few years, toxicological studies have shown that many herbicides can cause cancer and other chronic diseases. Epidemiological studies have also linked certain herbicides with cancer. In addition, because farmers are so familiar with herbicides, they tend to be lax about following safety precautions on product labels. So occupational exposure is a growing concern.

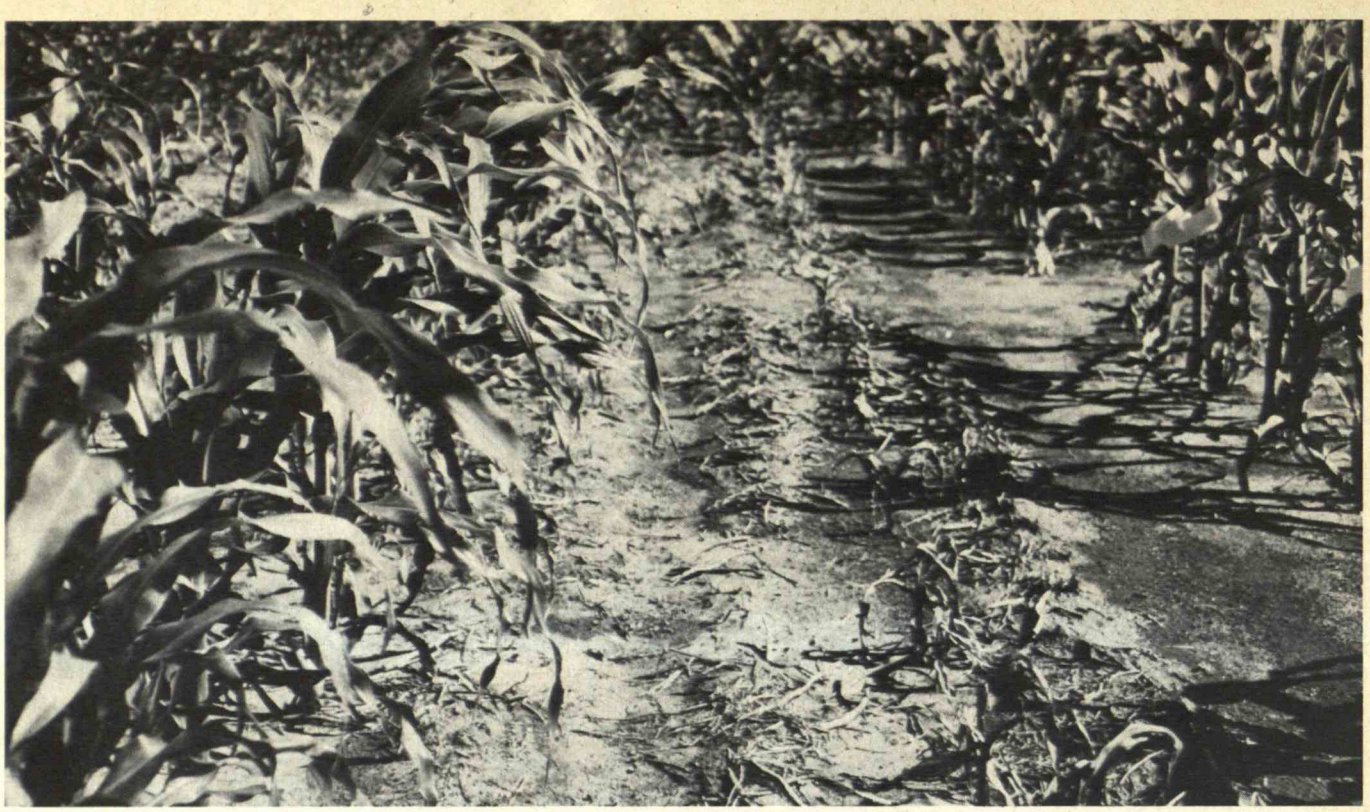
The recurrent detection of herbicides in surface-water and groundwater supplies creates broader public-health worries. Two of the most frequently detected contaminants—alachlor and atrazine—cause cancer in long-term animal tests. These herbicides are the most widely used in the United States. They are applied to about one in every three acres of cropland each year, primarily for controlling a wide variety of grassy weed species.

In the next few years, regulatory restrictions on certain herbicides could accelerate the rate at which newer and highly effective herbicides are adopted. At least six major herbicides were registered for crop use by the U.S. Environmental Protection Agency (EPA) in the first half of 1986. A comparable number are in the regulatory pipeline and likely to be available for the 1987 crop season.

BY CHARLES M. BENBROOK AND PHYLLIS B. MOSES

Left: Tobacco flowers are covered with paper bags to prevent haphazard pollination during conventional cross-breeding. This technique can be used to develop herbicide resistance in some plants.

PHOTO: JOHN COLWELL, GRANT HEILMAN PHOTOGRAPHY



Some new chemicals kill plants by inhibiting the action of certain enzymes that synthesize amino acids, the building blocks of proteins. But fish, insects, and mammals, including humans, lack the biochemical pathways upon which the herbicides work. So these species face little or no risk. Moreover, the herbicides either break down rapidly into carbon, nitrogen, and oxygen in the environment, or they do not leach appreciably into water.

The breakthroughs in weed-control chemistry include Monsanto Co.'s glyphosate, E.I. du Pont de Nemours & Co.'s family of sulfonylurea herbicides, and American Cyanamid Co.'s imidazolinone products.

These herbicides are highly effective and desirable from an environmental perspective. But their broad spectrum of activity is a roadblock to widespread use. Many of the chemicals discriminate poorly, if at all, between weeds and crops. They are not likely to be used to their full potential unless crops can be made to resist the toxic effects. This fact has fueled extensive private-sector research and development on herbicide-resistant crop varieties.

Seed, chemical, and biotechnology companies are starting to develop plant varieties that have natural or genetically engineered resistance to specific, highly active, broad-spectrum herbicides. These efforts and the technologies expected to evolve from them—such as herbicides designed for improved efficiency and safety—could begin to have profound effects upon weed-control practices and the herbicide market within 10 years. Of all emerging plant biotechnologies, the new herbicides and herbicide-resistant plant varieties probably offer the greatest potential for short-term gains in agricultural productivity.

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Exploiting Natural Resistance Traits

Plants naturally resistant to specific herbicides already exist. Their resistance stems from some special genetic trait. For example, wheat is naturally resistant to Glean, a sulfonylurea compound marketed by du Pont. Were it not for natural resistance, selective chemical herbicides for agricultural applications would not be possible: all herbicides would kill all plants.

Resistance traits usually take one of four forms. In one form, the plant does not absorb the herbicide. In another, the plant does not transport the herbicide into those tissues where it can do damage. Or the plant may detoxify the herbicide by breaking it down. Finally, the site within the plant's cells where the herbicide would act may not be susceptible. Sometimes the site is not susceptible because the herbicide cannot bind to the target protein, which may be an enzyme crucial for manufacturing a group of essential amino acids. In other cases, the herbicide can bind, but the target protein can still carry out its function.

Left: After an application of one type of imidazolinone, the left row of resistant corn grew, while the center row of non-resistant corn withered. Below: Lab tests show that the active ingredients of some broad-spectrum herbicides are less toxic than those of many other herbicides. More than twice as much glyphosate, imazaquin, or chlorimuron ethyl as alachlor or atrazine is needed to kill 50 percent of a group of rats. Crop lines are being developed to resist these broad-spectrum herbicides.

ACTIVE INGREDIENT	BRAND NAME	YEAR INTRODUCED	ACUTE TOXICITY (mg. of compound/kg. of body weight)	RATE OF APPLICATION (lbs./acre)
Broad-spectrum herbicides:				
Glyphosate	Roundup	1976	4,300	0.5
Imazaquin (an imidazolinone)	Scepter	1986	5,000	0.125
Chlorimuron ethyl (a sulfonylurea)	Classic	1986	4,100	0.03
Other herbicides:				
Alachlor	Lasso	1969	1,800	2.5
Atrazine	AAtrex	1967	1,780	1.8

Scientists can create resistant crops through conventional plant breeding, cell-culture techniques, and recombinant-DNA methods. Conventional plant breeding is the simplest route. It allows researchers to transfer naturally occurring resistance traits in crops or weeds to new species. For example, Canadian breeders have created resistant crops by crossing weeds resistant to the older, popular herbicide atrazine with rutabaga and rapeseed, an oil-producing plant. As a result, atrazine can be used on crops in northern latitudes, where field conditions render other forms of weed control ineffective.

The plant lines that resulted from conventional breeding of rutabaga and rapeseed had lower crop yields because the process interfered with photosynthetic responses. In general, however, scientists try to select crossed plant lines that do not differ from the parent crops except in resisting herbicides. They expect that such selection will be possible with the newer, broad-spectrum herbicides, although not many plant lines have been cultivated to resist them.

One difficulty with conventional plant breeding is that it can be done only with two closely related plant species. For example, to produce offspring, the plants' sex cells must have the same number and configuration of chromosomes, which carry the genetic information. Nature has evolved mechanisms, which are not completely understood, to make sure that very different plant species do not interbreed.

Cell-culture techniques, which may succeed when conventional breeding fails, can also halve the time needed to develop a resistant variety. The techniques involve growing whole cells in a petri dish. In one approach, a chemical is added to fuse a cell from a resistant plant with a similar cell from the susceptible crop. The parent plants must still be fairly closely related. Otherwise the fused, hybrid cell will not regenerate into an entire fertile plant. Once a fertile plant is regenerated, it must be backcrossed—bred for several generations with the crop parent, as in conventional breeding—to obtain herbicide-resistant plants that exhibit the original crop's desirable traits, including yield, nutritional quality, and disease resistance. This approach has been used successfully to transfer atrazine resistance into cultivated potatoes from *Solanum nigrum*, a related weedy species.

A second cell-culture method relies upon selecting those rare cells in a large laboratory culture that become resistant to the herbicide through mutations. These can occur spontaneously or with the help of mutagenic chemicals. Scientists induce the resistant cells to regenerate into whole plants by applying hormones. The regenerated plants are then tested for retention of the resistance trait. No backcrossing is needed if the cells come from the original desired crop variety. Several crops resistant to the new, broad-spectrum herbicides have been created through this cell-culture method. The successes include an alfalfa line that resists the compound glyphosate, corn that can withstand imidazolinones, and tobacco that can survive sulfonylurea herbicides.

Resistance through Recombination

Naturally occurring resistance traits and traits selected in cell cultures often stem from mutations in single genes. Genes, which carry traits encoded in DNA, can be manipulated by molecular biologists who isolate, further mutate, and recombine them in the test tube. The scientists then reintroduce the manipulated genes into plants.

Active research is focused on finding or creating resistance genes for a number of herbicides and transferring these genes into crops. Scientists must first understand the biochemical mechanism and metabolic target of an herbicide. Consider the development of several plant lines that resist glyphosate, one of the broad-spectrum herbicides. Detailed studies show that glyphosate kills plants and bacteria by binding to and inhibiting the action of an enzyme called EPSPS, which is needed to synthesize several amino acids. In 1983, scientists working at the bio-

PHOTO: ROB FINCHER, PIONEER HI-BRED INTERNATIONAL; CHART: RICHARD WILES, NATIONAL ACADEMY OF SCIENCES

California tomato growers could cut their weed-control costs by more than three-fourths by using herbicide-resistant plants.

technology company Calgene, Inc., in Davis, Calif., selected bacteria resistant to glyphosate's inhibitory effects. From these bacteria they obtained a gene encoding an EPSPS enzyme that resists glyphosate. They engineered this gene into tomato, tobacco, cotton, and poplar cells to grow plants that can tolerate glyphosate.

This strategy is feasible for many plant species. One variation is to select and engineer a resistance gene from plant cells rather than from bacteria. Another is to custom design a resistance gene in the test tube by chemically changing a non-resistant gene's DNA. This direct engineering is based upon chemical knowledge of the target protein's structure and its interaction with the herbicide.

Scientists have also found that they can overcome an herbicide's toxic effect by promoting surplus production of the target protein. To accomplish this, they splice certain regulatory signals into the plant's DNA. Monsanto scientists have used this technique to create tomato, tobacco, and petunia plants that resist glyphosate by producing 20 to 40 times more of the enzyme EPSPS. The scientists are striving to augment this resistance by directly engineering precise chemical mutations in the gene that would make EPSPS intrinsically resistant to glyphosate.

At the rate biochemical technology and techniques for genetic engineering are progressing, in about 10 years it will be as routine to create resistance genes via test-tube mutations as it is now to select such genes by contemporary cell-culture methods.

Corporate Payoff Potential

At least two dozen agrochemical and biotechnology companies are engaged in research to create crops resistant to chemical herbicides. The most extensive programs revolve around the three classes of broad-spectrum herbicides already mentioned: glyphosate and its related compounds, sulfonylureas, and imidazolinones.

The first and perhaps the only herbicide ever to reach $1 billion in annual sales—glyphosate, developed and marketed by Monsanto—indiscriminantly kills both crops and weeds. The remarkable commercial success of this product, which was introduced in 1976, stems largely from its broad array of uses, which offset the relatively high cost per pound of active ingredient: $22, in contrast with $4.50 for alachlor and $2.40 for atrazine. Today, glyphosate is used to control weeds in urban and industrial settings, to kill weeds, shrubs, and deciduous trees in forests, and to destroy aquatic vegetation. Because of its high cost, farmers use it sparingly for weed control before planting crops in reduced or no-till farming systems, and for range, orchard, and other specialty-crop situations in which the herbicide can be placed just where needed.

A decade ago Monsanto recognized the tremendous payoff to be realized by engineering glyphosate resistance into major crops. If resistant alfalfa, soybean, and corn varieties could be engineered, the prospective annual U.S. market for glyphosate would expand from a few million acres of cropland to nearly 150 million. To penetrate that market, the cost of glyphosate would have to fall somewhat. But if it did, the herbicide's profit potential could rise 10 times or more.

Even at today's prices, glyphosate would be cost-effective for certain farmers. For example, if a suitable tomato line were available, California tomato growers could spend just $30 per acre for weed-control costs, down from their current $130 per acre. The savings would result from eliminating both supplementary hand weeding and a combination of expensive herbicides that are only partly effective.

Glyphosate is not the only compound for which companies are developing resistant crop lines. Biotechnologists at du Pont, which developed sulfonylurea herbicides, have selected tobacco cells that resist sulfonylureas because of a minor change in the chemical structure of the target protein. Work is underway to transfer the resistance gene into corn, soybeans, and alfalfa.

At American Cyanamid, which created imidazolinone herbicides, scientists have regenerated imidazolinone-resistant corn plants from cultures of resistant corn cells. In a collaborative project with the seed company Pioneer Hi-Bred International, the resistance gene is being bred into Pioneer's corn lines. Researchers expect that careful backcrossing of resistant varieties with inbred corn lines will produce superior resistant hybrid lines ready for marketing by the early 1990s.

In our view, the companies' prospects for sales increases are modest compared with the total volume of business conducted by them. Only a limited number of farmers would likely switch to American Cyanamid's herbicide and Pioneer's seed corn at imidazolinones' current prices of about $120 per



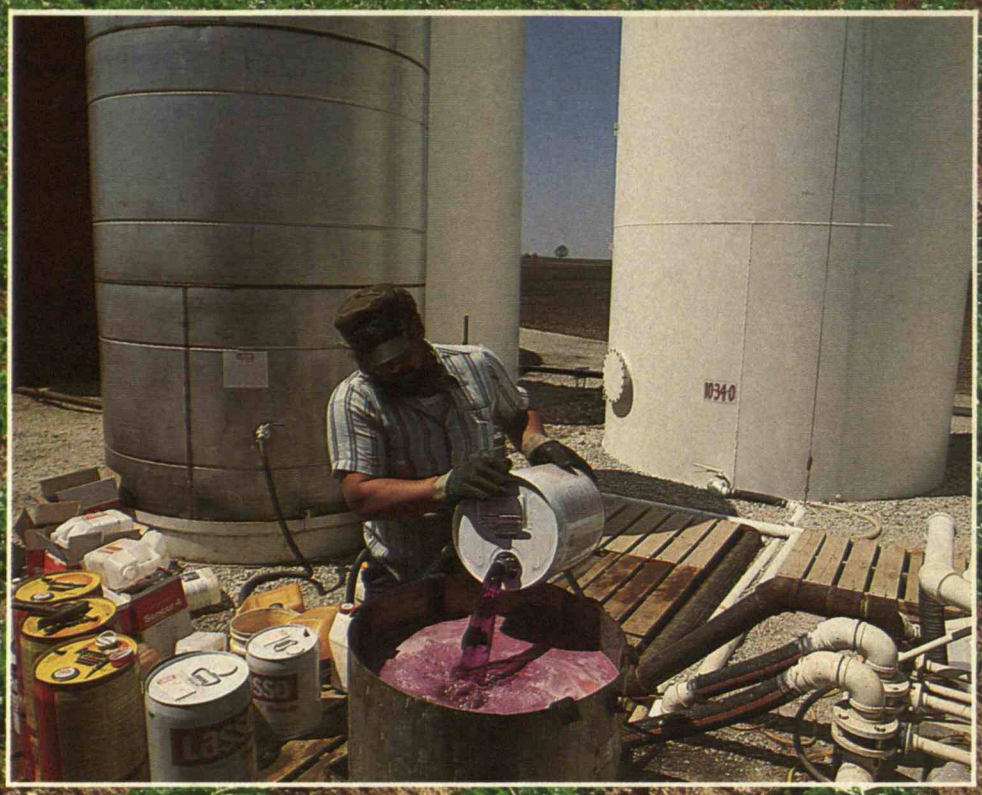
pound of active ingredient. Farmers have other well-proven, effective products available. However, many might switch if imidazolinones could be sold for perhaps $50 per pound—and if the performance of the new resistant hybrids proves comparable to that of other varieties.

But how well the newer products would sell would also depend on the possible competition from both new and old products. Moreover, farmers tend to be skeptical about new technologies. Many prefer to see how successfully they are used by others. In addition, the biotechnologies used in developing one resistant crop variety are likely to be applied with equal success to other varieties. Hence, crop varieties resistant to particular herbicides may be unique for just one or a few seasons. We do not expect that any single herbicide or crop variety will be able to offer sufficiently compelling advantages to set in motion major shifts in herbicide and seed selection.

For this reason, it is not likely that the structure of agribusiness will change dramatically simply because of herbicide-resistant plants. Critics fear that recent mergers of chemical and seed companies will enable some firms to gain a greater share of the herbicide market if they package the new compounds with herbicide-resistant plants. And presumably, farmers would be lured into paying more for such products. But many chemical companies that moved quickly into the seed industry are regretting their haste because the short-term profits that they once hoped for do not seem realistic anymore.

It seems to us that when the private sector finances research in herbicide resistance, the purpose is just as much to explore a valuable technological frontier as to reap short-term commercial gains. Research will lead to a better understanding of basic plant biology, and scientists will learn how to introduce other characteristics, such as disease resistance, into plants. Already scientists at Washington University, in collaboration with Monsanto, have genetically engineered tomato and tobacco plants to resist a viral disease that causes significant losses to farmers. Resistance research is also providing critical insights into how herbicides work. In the past, finding herbicides involved testing tens of thousands of compounds for their ability to kill weeds. In the future, herbicides may be designed to exploit a given plant's biochemistry.

PHOTO: JOHN COLWELL, GRANT HEILMAN



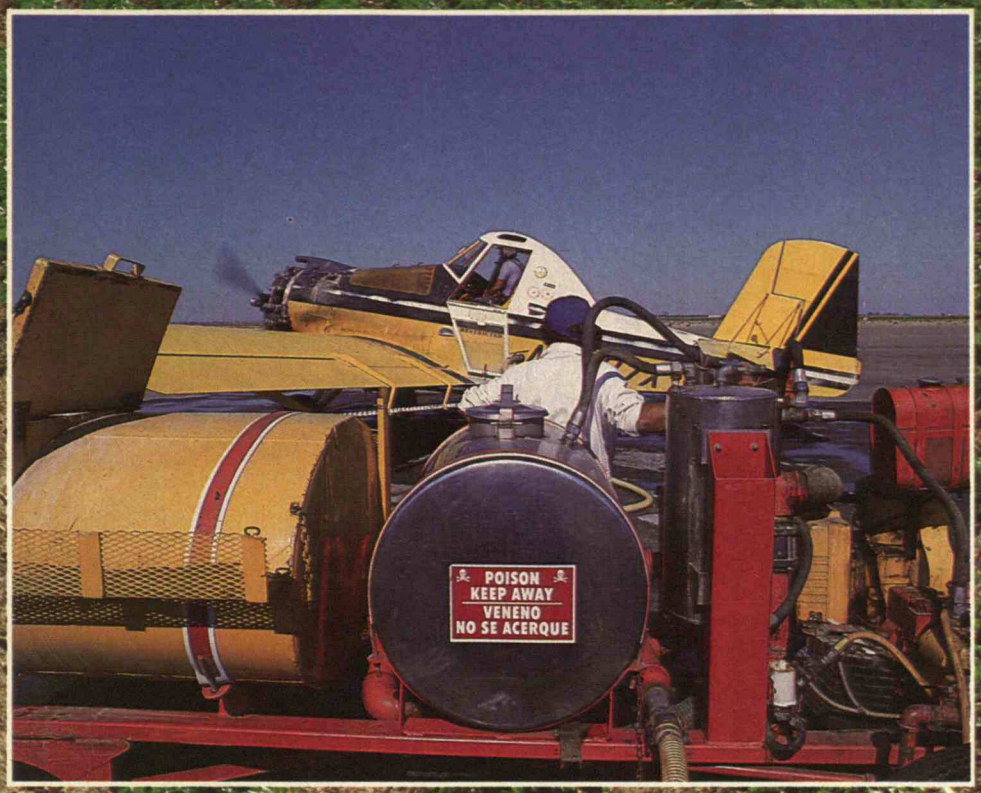
Government Approvals Expected

The company with herbicide-resistant plant lines closest to federal review is Calgene. Its glyphosate-resistant tomato, tobacco, and poplar lines are ready for field trials pending the requisite government approvals, which are expected. Despite considerable controversy about federal regulations for genetically engineered products, there is little indication that herbicide-resistant crops will face a challenge in the regulatory arena. No unique environmental or ecological concerns have been associated with resistant cultivated plant lines, regardless of fears about genetic engineering.

Arguments claiming that herbicide-resistant crops may pose ecological dangers do not hold up. One such argument is based on the notion that resistance traits could spread from crop plants to weeds. However, the 40-year history of synthetic-herbicide use provides surprisingly few examples of transfer of herbicide-resistance genes to and among weed species. There is no reason to expect the incidence to rise with genetically engineered resistant crops. Moreover, herbicide resistance in a weed species merely compels a change in farm management. Farmers have dozens of choices: mechanical cultivation, new herbicides, crop rotations, and so on.

A second concern that has been raised stems from the notion that a crop genetically engineered to resist an herbicide will somehow be physiologically weaker than the original variety or more susceptible to mutations. But it is very unlikely that flaws in a new variety could go unnoticed, given the sophistication of contemporary plant breeding. And even if weaker varieties did develop from plant breeding, they would not be commercialized. Seed companies thoroughly test new crop varieties.

Another argument sometimes raised against herbicide-resistance technology is that it will accelerate the world's dependence on a few crops and a narrow genetic base. History amply demonstrates that huge areas planted with a single crop variety can be devastated by a new disease or environmental problem to which that variety is not resistant. Yet there is little chance that herbicide-resistant varieties will substantially alter the genetic base of crop plants. Nor are they likely to have a significant effect on land-use patterns, which have already progressed a



Far left: The herbicide alachlor is poured into a container. Some herbicides would be better packaged in containers that dissolve in water. Farmworkers would avoid exposure during mixing. Left: An herbicide is loaded onto a spray plane.

long way toward monoculture in many regions of the world. Indeed, resistant varieties could actually decrease monoculture in some areas by allowing farmers to plant new crops and follow new rotations where weed-control problems had previously prevented changes.

Rather than posing unprecedented or unique environmental concerns, the new herbicides protect public health. They have not proven to be toxic to animals, including humans. And before gaining EPA registrations, they have had to withstand a much more complete battery of ecological and toxicity tests than most of the older herbicides. During the 1970s, the EPA toughened the rules for testing pesticides, largely in response to the environmental movement.

Tighter Regulation of Existing Herbicides

The tighter regulations are also requiring the retesting of the older herbicides. New chronic-toxicity data have become available on several older herbicides, including atrazine and alachlor, which account for 36 percent of all herbicide use in this country. In June 1986 the EPA received data indicating that atrazine increased the probability of malignant mammary tumors in rats. Data on alachlor submitted to the agency in 1983 raised even more serious concerns. This herbicide triggered several types of tumors in different animals.

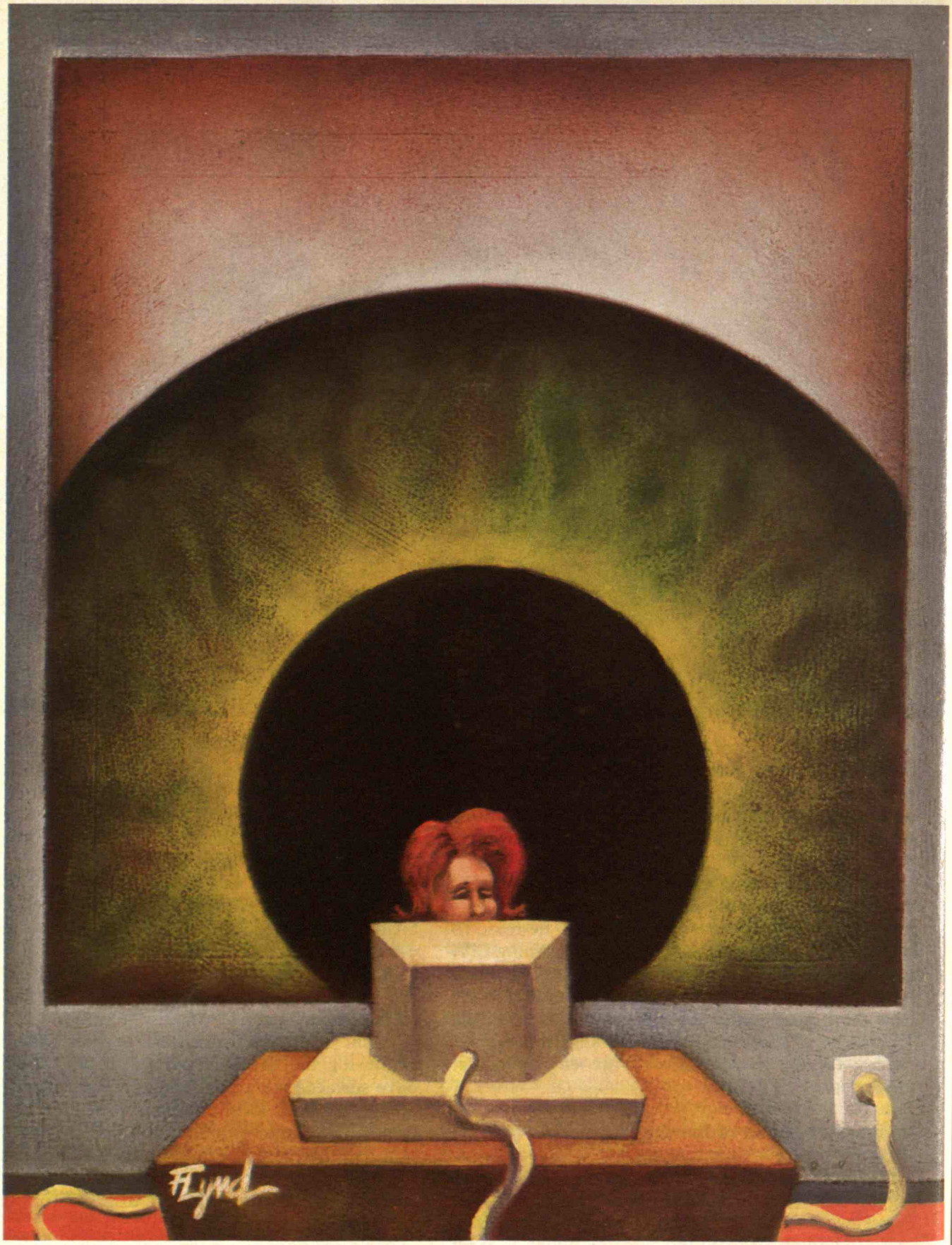
The information has raised new fears about the long-term consequences of farmers' exposure to herbicides. In addition, EPA and state officials have been evaluating the significance of exposure to these chemicals in drinking water. Alachlor and atrazine are found routinely in surface water in U.S. agricultural areas and migrate into aquifers.

Public-health risk from alachlor in drinking water is causing the EPA the most difficulty. Questions have surfaced regarding what level of cancer risk is acceptable for a local population facing a high risk or a distant, larger population facing a more uncertain risk. By early this fall, the EPA had banned the use of alachlor on certain crops, including potatoes, and was deliberating whether to restrict or ban its use entirely.

New regulations on several other carcinogenic

Continued on page 79

PHOTOS: GRANT HEILMAN; ALAN PITCAIRN


FLynch

Powerful new monitoring technologies can be used to improve workplace security, but they also threaten employee privacy rights.

MONITORING ON THE JOB

How to Protect Privacy as Well as Property

A LARGE manufacturing company hid microphones in the bathrooms of one of its plants in an effort to ferret out drug sales at work. The microphones were accidentally discovered, and the local union complained, claiming violation of a basic privacy right. Management defended the action as part of a program to eliminate drug use at work.

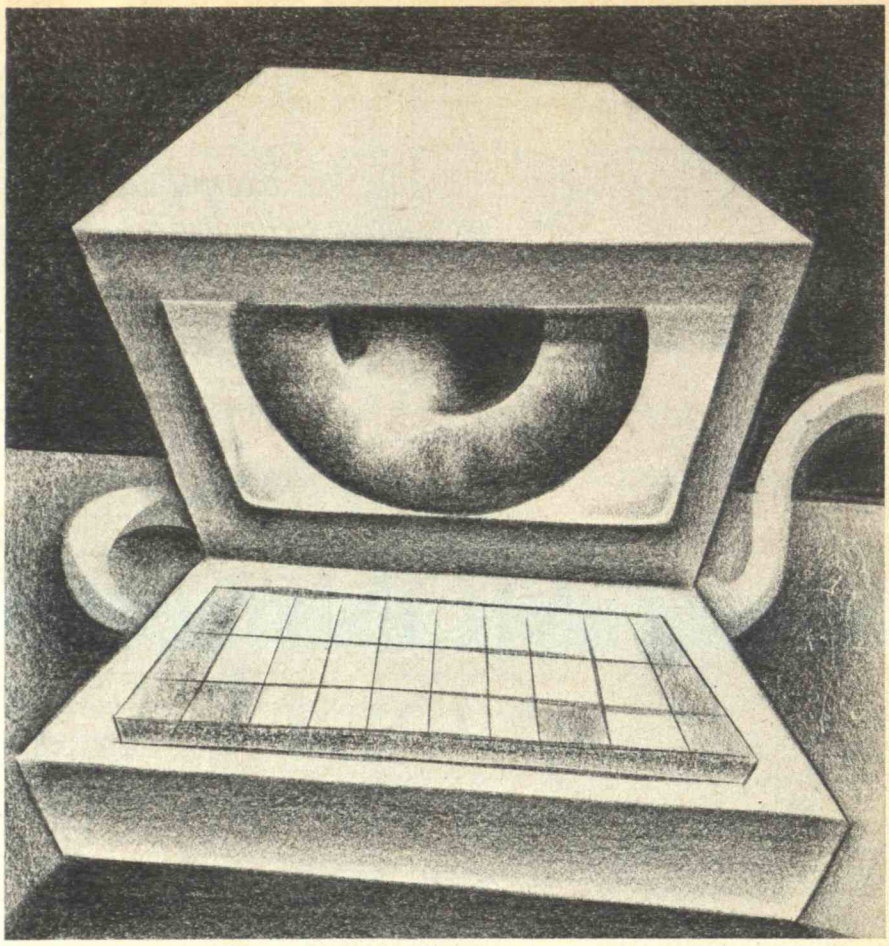
A bank conducted a random check of an employee's microcomputer and found a file of personal letters and a program for preparing income tax forms. The employee was warned to use the company's computer only for company business. The employee felt that her privacy had been invaded: it was as if the company had looked in her desk or purse and told her what could and could not be there.

Two workers left a factory as their shift ended, engaged in a heated discussion. A fist fight ensued, and a video camera designed to protect the company's parking lot recorded the fight. The employees were later fired. They protested that their activity outside factory gates was a private matter. A judge agreed and ordered that they be rehired.

The monitoring of workers is hardly a new phenomenon. Indeed, it has always been the responsibility of supervisors to watch workers. From the very beginning, factory systems were designed to facilitate managerial control. With the rise of mass production and the spread of the "scientific management" ideas of Frederick Taylor, jobs were divided into their smallest components. Time and motion studies were done to establish work standards and quotas. However, even then monitoring was essentially personal. It relied on individual supervisors, and

BY GARY T. MARX AND SANFORD SHERIZEN

ILLUSTRATIONS: FRED LYNCH



workers were likely to know when they were being watched.

In many ways, contemporary monitoring is a continuation of Taylorism. But new developments in electronic technology are taking that ethos to new heights (or lows, depending upon your point of view). The monitoring of employees is increasingly being done by machines. Much more is being monitored, and the monitoring has expanded from the production line to the office.

People may not know they are being watched. Furthermore, monitoring is no longer restricted to a bounded work setting such as a factory or an office. It can be done anytime, day or night, and from a location far removed from the actual work setting. Thus, an employee using a company computer at home can be observed, and a simple electronic transmitter can monitor the movement of people and vehicles far from the central office. Traditional social and legal protections are not as clearly applicable.

U.S. managers are under increasing pressure to monitor and improve productivity. Many companies also share a growing concern about product security and employee theft. Manufacturing processes and electronic systems for transmitting data and transferring funds are far more complex than they used to be, increasing the potential for costly abuses and errors. Rising concern over drug use at work, AIDS, and escalating health insurance costs also exerts pressure on managers to conduct more intensive screening and monitoring.

As a result, the concept of privacy itself is changing. In the name of improving company security and enhancing worker productivity, intrusions that would have been questioned or rejected in the past are now being accepted. The boundaries between acceptable and unacceptable intrusions are less clearly drawn. Where is the line between on- and off-duty behavior? When does the factory or office stop and the home begin? In the future, we may even have to confront questions about the right to control brainwaves and other biometric indicators thought to be relevant to work.

American companies today are at a crossroads. They can use new electronic technologies to increase their control over worker behavior and reinforce traditional patterns of nonparticipatory management. But such efforts will erode individual rights to privacy and may cause psychological stress and reduce productivity. Fortunately, companies can use the new monitoring technologies in a restricted fashion, recognizing that just because an intrusive form of monitoring can be done does not mean it *should* be done. With employee participation in setting standards and fair guidelines, some monitoring can even enhance privacy, security, and productivity.

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The Value of Privacy

Privacy is not a simple concept with only one meaning. It embodies a variety of meanings and expectations. For instance, most Americans expect that an individual's behavior will not be observed, moni-

Just because an intrusive form of monitoring can be done does not mean it should be done.

tored, or recorded without that person's consent. They expect not to have to divulge personal information that is not directly relevant to the issue at hand. And they expect that the information they do divulge will be treated confidentially and not used in unexpected ways. Laws and administrative rules often tend to support these views.

But why is privacy so important in the first place? Privacy is an essential component of individual autonomy and dignity. Our sense of liberty is partly defined by the ability to control our own lives—whether this be the kind of work we undertake, who we choose to associate with, where we live, the kind of religious and political beliefs we hold, or the information we wish to divulge about ourselves.

Control over personal information is particularly important for our sense of self. When an individual's room, pocketbook, or body can be searched at will, when conversations and even thoughts are available for instant inspection by outsiders, openness and honesty lose their value. Distrust becomes institutionalized and an important and even sacred element of the social bond is damaged.

In practice, of course, privacy is not easy to protect. The privacy rights of different individuals or groups sometimes conflict. For instance, an employee's right to keep personal certain information about his or her health conflicts with an employer's interest in knowing about health conditions that may affect performance and medical insurance costs. An employee's right to know about hazardous conditions at work may conflict with an employer's right to protect proprietary information.

The issue is also complicated by the fact that privacy rights depend heavily on context. Intrusive behavior considered acceptable on the job is not always acceptable off-duty. Police wiretapping of suspected drug dealers with a warrant is one thing; employers wiretapping employee telephone calls is quite another. A supervisor watching employees on an assembly line is not likely to be questioned. But the use of a hidden camera and bug to gather equivalent data is. There are few, if any, forms of intrusive behavior that all people would agree are always illegitimate.

The Maximum-Security Workplace?

In a less technological age, our expectations about privacy were defined partly by what the unaided senses—sight, sound, smell, taste, and touch—were capable of detecting. The traditional physical boundaries of the workplace offered other limits to the gathering of information. Today's monitoring technologies easily transcend traditional barriers to data collection. Since monitoring is increasingly done automatically by machines, supervisors are no longer limited to what they can immediately observe. Nor are workers always able to know when they are being monitored. Phone systems designed as intercoms or paging devices permit managers to listen to conversations in other offices without being detected. Even in the few cases when union contracts or state laws require that notice of monitoring be given, workers will not necessarily know when the monitoring is being done.

Compare, for example, a video camera or video recorder with the traditional supervisor who occasionally walks by. Workers usually know when the supervisor is present. They also know that the monitoring is episodic—the supervisor can't be everywhere all the time. In contrast, camera and recorder are omnipresent and tireless; the worker can never be sure whether they are in operation or if their results will be reviewed. Moreover, in the past, the economics of monitoring tended to work against intensive mass surveillance. But technological breakthroughs have greatly reduced the cost of monitoring. Some companies are even using satellite technology to pinpoint the location of their trucks on a television screen.

Furthermore, monitoring devices with built-in microprocessors can now be made very small. This means that they can be placed in hidden locations and activated from distant places. By installing a tiny pinhole lens and video on the plane, for instance, it is possible for people on the ground to see and hear all activity on an aircraft up to 200 miles away. The market for such security products is expected to grow from $774 million in 1985 to $2.1 billion by 1992.

Workers increasingly participate in their own monitoring—even though such participation may be unwilling or unconscious. Technical devices automatically record data that workers generate: they capture information from the workers' voices or movements such as keystrokes or assembly-line actions, and they measure workers' effectiveness by monitoring security and quality-control systems. In data-processing jobs, for instance, the devices mon-

The camera and recorder are omnipresent and tireless; the worker can never be sure whether they are in operation.

itor the number of errors and corrections made, the speed of work, and time away from the desk. One Bank of America vice-president, commenting upon the 200 criteria he uses to assess productivity among workers in his credit-card division, notes: "I measure everything that moves."

The workers most likely to be monitored are those who use computers for telecommunications, word processing, programming, and service contacts. Companies such as AT&T, United Airlines, Equitable Life Insurance, and American Express use sophisticated devices to regularly monitor their employees.

Take, for instance, the development of a technique called station message detail recording (SMDR). Telephone systems often have built-in SMDR features that record on what telephone each call is made, what user identification code and extension is used, where the call goes, what time it is made, and how long it lasts. SMDR systems generate detailed reports that management can use for planning budgets, allocating and controlling costs, and monitoring activities. Among the functions that can be monitored are toll calls made after official business hours and telephone use during lunch hours. Employees who use the telephone to make personal calls can readily be identified, as can employees who leak information to the press or to competitors. Calls from one extension to another within the company can also be monitored. New developments in software also make it possible to capture the content of a conversation, although this is much less frequently done.

The monitoring of telephone communication is likely to become pervasive. In 1985, 20,000 SMDR and related systems were sold in the United States, and that number is likely to grow. As one airline-company executive put it, "Communications performance monitoring is going to be one of the major computer service fields in the next 5 to 10 years."

Thanks to other advances in software, employers can monitor employees working on microcomputers from the time they log on to the time they log off. One software product now on the market allows management to document the activities of anybody using the company computer system—without the user's knowledge. With the program, marketed by Clyde Digital Systems of Provo, Utah, and called "CNTRL," managers can observe on their own screen all input entered by the employee and all output from the computer to the user's terminal as it occurs. It can also be captured in a log, "creating a certifiable record to be used for disciplinary or legal proceedings," as the company's literature promises.

Software companies have even developed programs that allow employers to tell workers how their productivity compares with that of their co-workers. One program can be used to display messages on the video display terminal such as: "You are not working as fast as the person next to you."

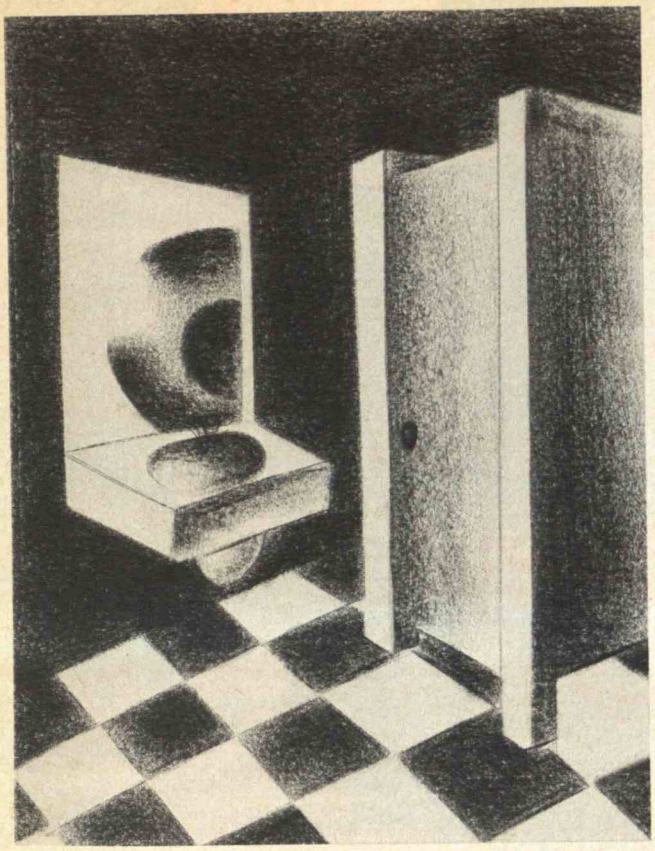
A report by 9 to 5, the national organization of working women, describes a program called "The Messenger" that can be called up by the VDT operator. Calming images of mountains and streams are displayed along with subliminal messages such as "My world is calm." More ominous are subliminal programs that the worker may have no knowledge or control over. One such program entitled "Subliminal Suggestions and Self-Hypnosis" permits management to send any kind of message—such as "relax," "concentrate," or "work faster"—unbeknownst to the worker. The messages pass so quickly in front of the watchers' eyes they cannot be consciously detected.

Your Retinal Pattern or Your Life

Information security is a growing priority for many companies, particularly those involved in complex electronic fund transfers or confidential communications. The ability to gain remote access to computer systems had long posed a security problem, largely because both hackers and those with much less technical knowledge have found ways to bypass traditional precautions such as passwords and special cards.

To prevent unauthorized use, security firms are now developing biometric identification products for the commercial marketplace. These are based on the sensing of individual characteristics such as fingerprints, handwriting, voice, typing rhythms, hand geometry, and the distinct patterns of people's retinas. *Personal Identification News* magazine estimates that private companies spent more than $35 million in 1985 to develop biometric products.

These products can indeed improve the ability of federal agencies and private companies to limit access to top-security data. But they are also being used as a substitute for other managerial controls and supervision. A leading hotel, for example, used retinal-pattern identification to prevent workers from



punching in one another's timecards. And a growing number of organizations ranging from Avis, Con Edison, and Equitable Life Insurance to the Universities of Tennessee and Georgia use hand geometry to identify employees.

The new technologies, of course, may bring greater equity. After all, "pre-technological" monitoring by a human supervisor sometimes meant high-handed or discriminatory treatment. Technological monitors have no favorites; all workers are treated alike. Because so many parameters of job performance can now be monitored, the total result might be a fairer system. Furthermore, monitoring can extend up as well as down the organizational hierarchy. Video cameras, card key systems required to enter a room, and computer access codes make demands on all who encounter them.

However, intrusive monitoring may conflict with workers' traditional expectations of what is fair on the job. There is, of course, no formal protection for the privilege of whispering at work or of being free from observation. But most of us feel entitled to a sense of privacy in our communications at work. The new technologies are threatening that privacy and—for some workers—making it obsolete.

The use of biologically based technologies could jeopardize people's privacy off as well as on the job. Workers have already been fired from their jobs when drug tests have revealed evidence of marijuana use, even though the drug was used at a weekend party and job performance was not in question.

When Deception Becomes the Rule

The increased use of monitoring in the workplace could well backfire. People are wonderfully ingenious at finding ways to disrupt, distort, and deceive monitors. For example, typists may hold one key down to increase the number of key strokes recorded. They can always delete the file containing the errors later. Telephone reservation agents may learn to avoid calls that add to their average case time—by either disconnecting the call or simply withholding information. And workers required to provide urine samples may add chemicals that distort the test results or even turn in someone else's urine.

Monitoring may also create more adversarial relationships in the workplace. Workers may feel violated and powerless in the face of the new monitoring technologies. The result could be low morale, reduced productivity, and destructive countermeasures. Monitoring may even increase the violations or abuses it is intended to stop. Workers may feel challenged to beat the system or react out of anger and estrangement. When people feel they are not trusted, they often adopt an attitude similar to that of some police regarding corruption: "If you've got the name, play the game." In other words, as long as everyone thinks that you will take graft, you might as well do it.

One truck driver for the Safeway Co. with 40 years of experience recalled that he used to love his job because "you were on your own—no one was looking over your shoulder. You felt like a human being." But now a small computer on the dashboard of his truck (with the apt name of Tripmaster) keeps track of speed, shifting, excessive idling and when and how long he stops for lunch or a coffee break. As a result, the driver says he will retire early. He complains, "They push you around, spy on you. There's no trust, no respect anymore."

No comprehensive information exists on how technological monitoring affects productivity, but anecdotal evidence shows that overly zealous monitoring can be counterproductive. One large Midwestern electronics company for instance, found that productivity declined and absenteeism, stress, and turnover increased after a highly touted monitoring system was installed. The company eliminated the system within the year. The employees may have reacted like the directory-assistance operator who couldn't understand why her company had started

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A solo PC user becomes a one-man gang when the computer is AT&T's PC 6300 PLUS. Equipped with Simul-Task, the computer can run several programs at once.

While this user prepares a budget forecast, his AT&T PC can simultaneously print out a letter and share data with a remote mainframe, or with the work group at right.

HOW TODAY'S MOST PRODUCTIVE PCs

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The secret: Simul-Task technology allows today's AT&T computers to apply their power to several tasks at the same time.

Whether you work alone or as part of a group, you can now perform a database sort and print from a spreadsheet *at the same time* you edit a letter. You can send or receive electronic mail, or pull figures from a faraway mainframe *at the same time* you outline a report.

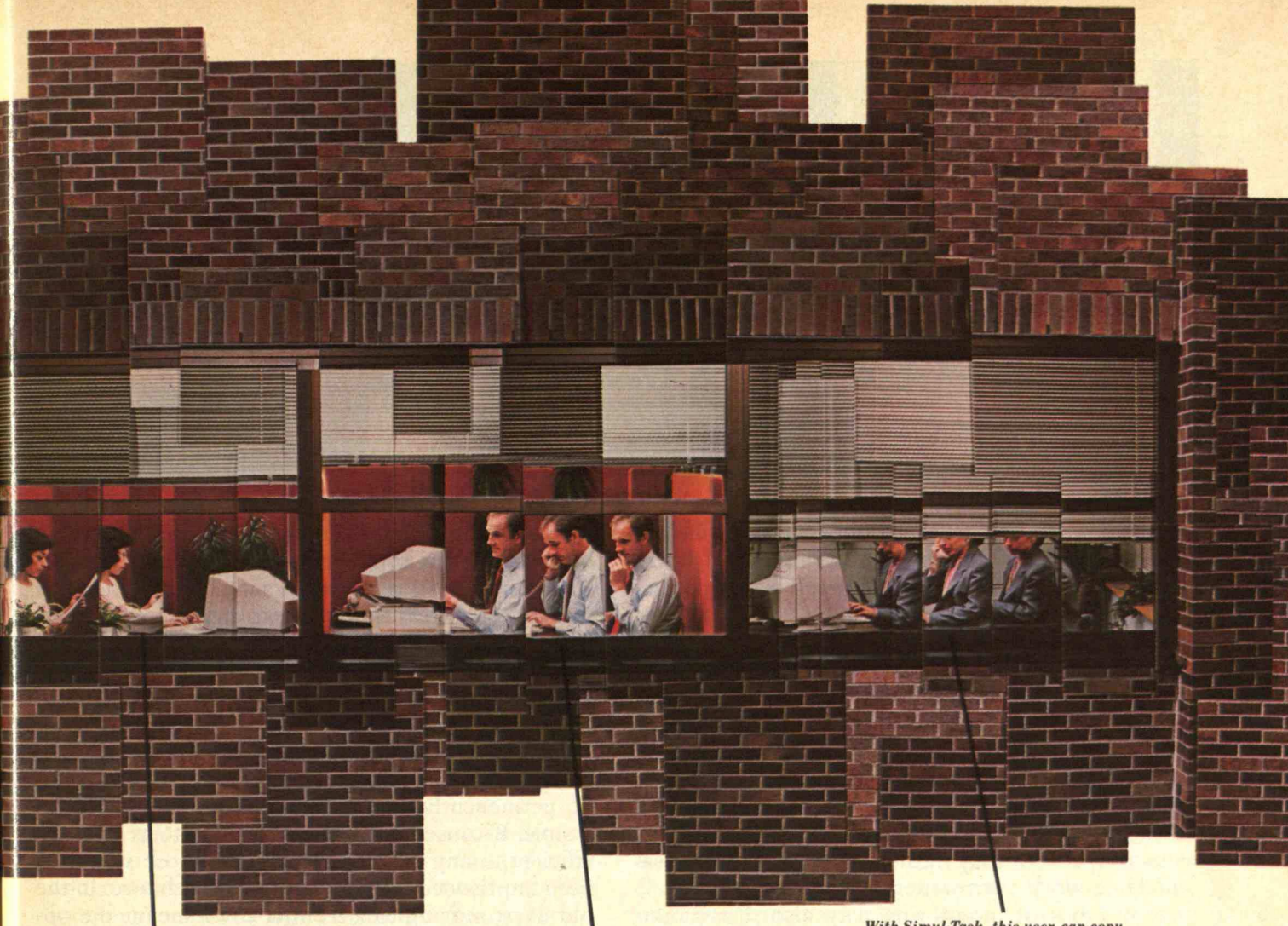
In a Simul-Task world, you need never interrupt one job to handle another. Quick as you can fire up new work in the foreground, Simul-Task gets on with other work in the background. (Which, incidentally, is rarely more than a keystroke away.)

Nor need you wait, ever again, for the computer to slog through time-consuming backups and sorts. Simul-Task frees you from such dreary chores, so you can apply your brains to more creative work.

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AT&T's PC 6300 PLUS is ranked among today's premier single-user machines. The speed is intoxicating, the graphics razor-sharp. However, it is AT&T's Simul-Task that catapults this IBM*-compatible into a class of its own.



AT&T's 3B1 Computer supports up to 5 users, each doing several jobs at once. Analysts compare this system to refrigerator-size minicomputers costing ten times as much.

A unique one-two punch: AT&T's Simul-Task feature delivers advanced communications functions and the ability to run multiple programs at the same time.

With Simul-Task, this user can copy information from one application directly into another application, doing in minutes what used to take hours.

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Simul-Task unleashes the full potential of the "80286" processor chip, running virtually any of your PC programs—while doing several other jobs at the same time. Result: You have all the advantages of today's PC software, without the limitations of today's one-thing-at-a-time PCs.

AT&T's 3B1 Computer has power and memory to spare for work groups of up to 5 users, each doing several tasks at once. Larger members of AT&T's 3B family of multi-user computers can extend the advantages of Simul-Task to larger groups and to whole companies.

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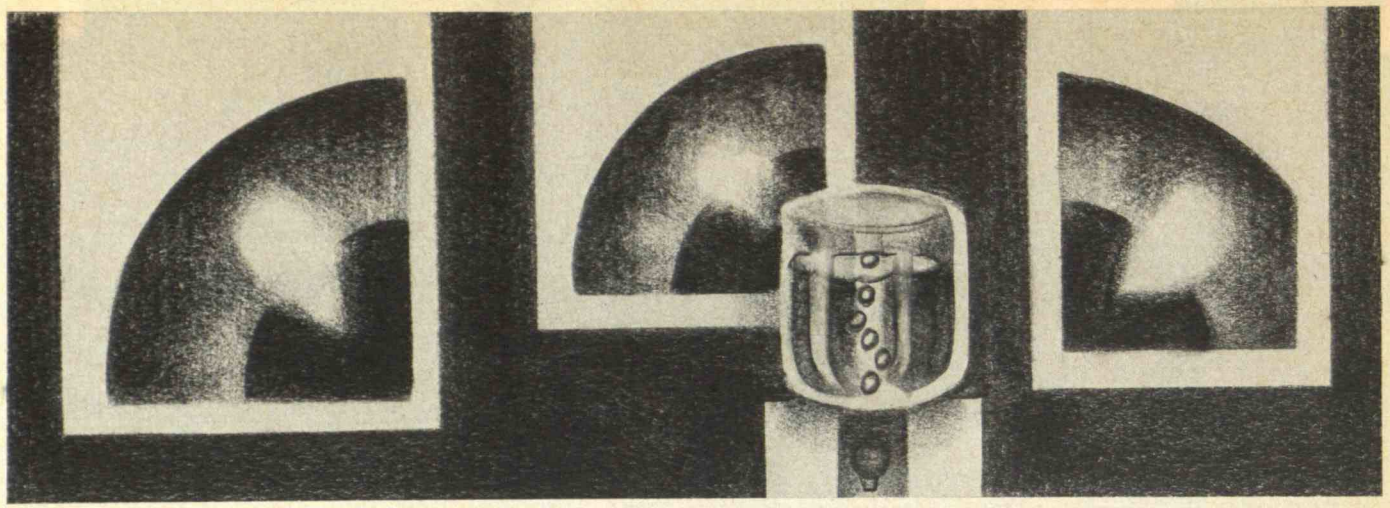
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monitoring her: "I worked all those years before monitoring. Why don't they trust me now? I will continue to be a good worker, but I won't do any more than necessary now."

Increased monitoring can breed other problems as well. The emphasis on quantity at the expense of quality may result in an inferior product. With monitoring, employers can automatically speed up the work process so it is no longer in the employees' control. Also, to the extent that electronic supervisors displace people, the potential for growth and learning on the job may be diminished. Less contact with a supervisor may mean a more impersonal, less satisfying work environment.

New types of monitoring may also disrupt understandings between labor and management. The technologies may eliminate activities that workers have traditionally taken for granted as "perks" of the job. For instance, many employees (and enlightened employers) equate the custom of keeping personal letters in an office computer with the tradition of taking home paper and pencils. Yet under the new form of monitoring, such previously "tolerated" behavior may no longer be accepted.

Surveillance also has a tendency to expand. Under the Reagan administration, government agencies have already begun monitoring their employees extensively, and further monitoring is planned. Polygraph testing, once restricted to top-secret matters of national security, is now applied to leaks to the press. In an effort to stem such leaks, some government agencies also monitor employee phone use. One new computer program even compares a list of calls with reporters' phone numbers. Concern about employee drug abuse has led President Reagan to urge drug testing of many government employees as well as employees of government contractors.

There is another reason for making sure technological monitoring in the workplace does not get out of hand: monitoring could become much more extensive in society at large. Practices developed at work can easily spill over into other areas. The new biometric forms of identification are one example. The more widespread this practice becomes in the workplace, the easier it will be to create a mandatory national ID system.

A Permanent Class of Undesirables?

Another danger is that monitoring—in the form of pre-employment screening—may help create a class of permanently unemployed and underemployed people. Because traditional records systems were inefficient, many people, particularly those who had been imprisoned, were given a second chance. In the old days, moving to a frontier town meant the opportunity to start over. But this traditional freedom may be severely constricted as credit institutions and other organizations gather comprehensive databases on U.S. citizens and sell them to other companies. The past becomes haunting: there is no second chance.

An increasing number of database companies gather and sell information to prospective employers on everything from an individual's political activism to the filing of worker-compensation claims. These companies are relatively unregulated in their use of the databases. One factory worker was fired from a new job after his employer checked with a private computer network that tracked such claims. The employee had filed two claims for minor injuries (such as a broken finger) with previous employers and had collected modest compensation.

Many companies also use written tests to screen out job applicants. The Knight-Ridder newspaper chain, which owns the *Miami Herald* and the *Philadelphia Inquirer*, routinely requires applicants for reporting positions to take a battery of written tests designed to reveal their personality traits and philosophical views.

Other forms of monitoring—such as genetic screening—could eventually be used to discriminate

Monitoring may even increase the violations or abuses it is intended to stop.

against individuals not because of their past but because of statistical expectations about their future. People who carry antibodies to the AIDS virus but have not developed the disease are already being discharged from the U.S. military and isolated or fired from other jobs. Scientific advances are making it increasingly possible to identify the genetic traits that predispose people to widespread diseases such as diabetes and heart disease.

Eventually, the work force may become divided between people thought to be good risks and others. Not only would this create an enormous waste of human resources as people are locked out of jobs for which they are otherwise qualified, but some of these people could turn to crime to support themselves. The demands on the welfare system would certainly expand.

Omnipresent monitoring will almost certainly chill political and social expression. Security and control may be enhanced but at the cost of a less creative and dynamic society. If American democracy is to be destroyed, it is unlikely to happen by sudden catastrophic events. Rather, it will occur by slow, incremental changes defined in benign terms. As Justice Louis Brandeis said, "The greatest dangers to liberty lurk in insidious encroachment by men of zeal, well-meaning but without understanding."

Using Technology to Enhance Privacy

Monitoring need not always mean invading some aspect of privacy. In some cases, technological monitoring is actually less intrusive than direct human monitoring. Electronic monitoring of hand luggage at airports eliminates the need for direct searches of passengers' purses and persons. The use of electronic markers on library books and consumer goods also makes costly and demanding physical searches unnecessary.

New technologies can also be used to reduce the need for monitoring and protect privacy. Monitoring in some ways is an admission of the potential for a system to fail. One watches because things *can* go wrong. However, work situations can be structured so that violations, abuses, and errors are less possible. Under these conditions, technological developments can enhance privacy.

For instance, data encrypted on fiber-optic telecommunications lines are clearly more secure from unauthorized use than information left in a desk drawer or file cabinet. Telephones can be designed to allow users to dial only local calls, eliminating the need to monitor for long-distance abuse.

Access keys or codes for using computers and copying machines reduce the need for visual surveillance. Before such systems were developed, supervisors had to watch who was using copying machines and in some cases resort to informers to locate abusers. Where once telephone company staff had to listen to conversations to verify the quality of connections, technical developments now make it possible to do this without listening in on voice communications.

In the future, "smart cards" containing personal data carried by everyone may eliminate the need for central databases, returning us to an earlier period when personal data were much more in the possession and control of the individual. In one inexpensive "smart card" system, laser technology is used to encode and read a wallet-sized card that contains up to 800 pages of information. The information on such cards is constitutionally protected from unauthorized use—which is not the case for records held by a third party such as a bank. However, backup copies would have to be made, creating the potential for abuse. Furthermore, if carrying such cards became mandatory, they might well seem more Orwellian than central databases.

Even technologies that have the potential to invade privacy may have positive benefits for employees. Some workers welcome close monitoring when it is tied to a system of merit pay. The permanent records from monitoring can also protect the innocent from false accusations and document violations by the guilty. Video cameras designed to prevent theft from loading areas may increase safety in adjacent parking lots. And drug screens may prevent accidents and protect the health of employees.

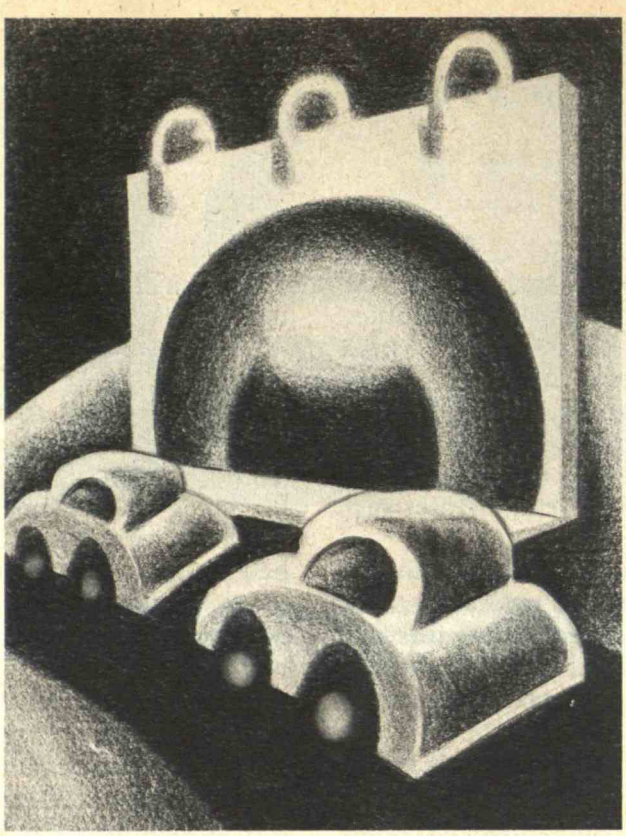
Establishing a Code of Ethics

Given the new technologies' wide range of advantages and disadvantages, how best can we manage their use? Companies should begin by analyzing why they want to institute monitoring. For instance, will the monitoring be a direct part of the work process, or will it be added on—a procedure apart from the work process such as a drug screen?

Most monitoring technologies can be applied in a number of ways. A video monitor can be hidden or

visible, operated randomly or only when a light is on. Drug testing can be based on an inexpensive and relatively unreliable test or the opposite. Drug tests, polygraphs, and other forms of inspection can be general or specific, scheduled or random.

Given the variety of instruments, uses, and contexts, sweeping generalizations about monitoring technologies are inappropriate. In general, however, privacy is best protected when monitoring is minimally intrusive, is directly relevant to job performance, and is visible—i.e., a supervisor is walking by or a video camera has a flashing red light that indicates it is on. Highly intrusive forms of checking that are not directly related to work output should be restricted to situations where there are some grounds for suspicion.



Monitoring is no longer restricted to a bounded work setting such as a factory or an office.

A code of ethics does exist among certain manufacturers and vendors of monitoring technology. For example, AT&T, which provides telephone companies equipment for checking phone lines, requires subscribers to agree that they will use it solely for quality control and training. AT&T also requires that employees be notified in writing that they will be subject to such monitoring.

Some firms ask employees to help establish behavioral norms at work and thus cut down on the need for monitoring. For example, some companies have instituted programs whereby, if losses from employee theft are less than the previous year, employees split the money saved. Following a widespread practice in Europe, a few U.S. companies have agreed to use work monitoring only for group, rather than individual, output.

As the new monitoring technologies become pervasive and affordable, however, misuses are bound to increase unless clear guidelines are developed. Our work in analyzing and developing information-security and privacy programs for companies and government agencies has made it clear that legislation and company policies must:

☐ Apply to monitoring the same protection that applies to pre-employment background checks—that is, permit only information directly relevant to the job to be collected. The burden of proof for the need to monitor should lie with the employer.

☐ Require employers to provide employees with advance notice of monitoring as well as appropriate mechanisms for appeal.

☐ Require people to verify machine-produced information before using it to evaluate employees.

☐ Provide workers with access to information on themselves.

☐ Provide mechanisms for monetary redress for employees whose rights are violated or who are victims of erroneous information generated by a monitoring system.

☐ Apply a "statute of limitations" on data from monitoring. The older the data, the less their potential relevance and the greater the difficulty employees have in challenging the information.

Little is known about the extent of employee monitoring in the United States and the policies that govern its use. Research by companies and government agencies could provide policymakers with a greater awareness of monitoring as a social phenomenon.

In sum, technology is neither the enemy nor the solution. More and more U.S. companies are turning to monitoring devices to increase their control over employee behavior and improve internal security. But thus far, society has paid insufficient attention to protecting individuals' rights. The U.S. government and the private sector must work together to make sure that in our haste to protect our property, we do not destroy our basic freedoms. ☐

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CONTINUED FROM PAGE 26

missile system.

There has also been concern both in the administration and Congress about the expense of the Midgetman program. To develop, deploy, and operate about 500 Midgetman missiles over their expected life would cost about $40 billion to $45 billion, including personnel costs. Proponents of the MX like to say that we could buy another 50 MX missiles and deploy them in silos for only $2 billion, which would make the cost for 500 deployed MX warheads far less than that for 500 Midgetman warheads. Others suggest that we should simply add a few more Trident submarines, which would also be cheaper.

But Congress—which only after a devisive fight approved just 50 of the Scowcroft Commission's recommended 100 MX missiles—will certainly not approve another 50 MX missiles without also agreeing to some new and extremely secure basing concept for them. A number of methods of basing, such as "superhard" silos, are under study, but all are expensive enough to substantially erode the MX's cost-per-warhead advantage to the Midgetman. When price is computed on a survivable-warhead basis, Midgetman is the sure fire winner.

As for submarines, the current generation of sea-launched ballistic missiles is far less capable of destroying very hard targets than either the MX or the Midgetman. This deficiency will be reduced, but not remedied, after the navy deploys its next generation of such missiles.

Lower Costs, Heavier Missiles

Some analysts accept the need for a mobile missile, but have asked why the Midgetman should not have several independently targetable warheads. That would reduce costs per warhead but would require a bigger, heavier missile. Variants ranging from a 52,000-pound missile with two warheads to a 75,000-pound missile with three warheads have been studied this year. The results should lead to a final Defense Department recommendation to the president in late fall.

Preliminary indications are that at a missile weight of 75,000 pounds and up, the launcher's mobility would decline so drastically as to completely overshadow the potential cost savings from a three-warhead payload. Even if the missile weighed 52,000 pounds, the launcher's weight would cut back the total area available for dispersal. Thus, fewer Soviet missiles would be needed to destroy the system. I maintain that the higher costs of the lightweight Midgetman will be justified by its ability to deter the Soviets from attacking first.

The Midgetman's most tenacious critics in Congress and the administration are almost invariably strong advocates of the Strategic Defense Initiative. This program, which is a response to the president's long-term vision of an impregnable defense for all U.S. citizens, is gradually changing in the hands of scientists and engineers into a near-term defense of missile silos. Estimates of the costs of such a defense range as high as $1 trillion.

The Midgetman does not require a defensive system, costs far less than any form of SDI, is based on well-known technologies, and is eminently compatible with arms control. SDI, in contrast, is seriously impeding arms-control agreements. One can wonder whether some of the more zealous efforts to block Midgetman are not, in reality, efforts to protect SDI by eliminating a more plausible competitor.

In my view, logic and common sense are going to prevail. However, time is not on the side of the Midgetman. In this era of the Gramm-Rudman Act, the missile has many competitors for defense dollars, and it may not be funded at optimal levels. Funding cuts mean delay, and enough delay would be tantamount to a death warrant.

Changing the Midgetman's design at this late date would have the same effect. Should the secretary of defense endorse proposals for a mobile multiple-warhead missile this fall, political support for it could collapse at once. Even if support remains, reworking the design could take two years. During that time costs would inflate and bipartisan support would erode, setting up the missile to become a victim of changing priorities and politics in the next national election.

The Midgetman as currently proposed is an elegant solution to many previously intractable issues obstructing U.S. defense modernization and arms control. Congress should sustain the Midgetman's funding at a level that will enable deployment to begin in 1992. The administration should reaffirm the missile's design no later than this December. And the program should be completed the way it began: as a project of the highest national priority. □

Scientists and Journalists, and Military Effects on Civilian Technology

When Scientists and Journalists Interact

Scientists and Journalists
Edited by Sharon M. Friedman, et al.
Free Press, $24.95

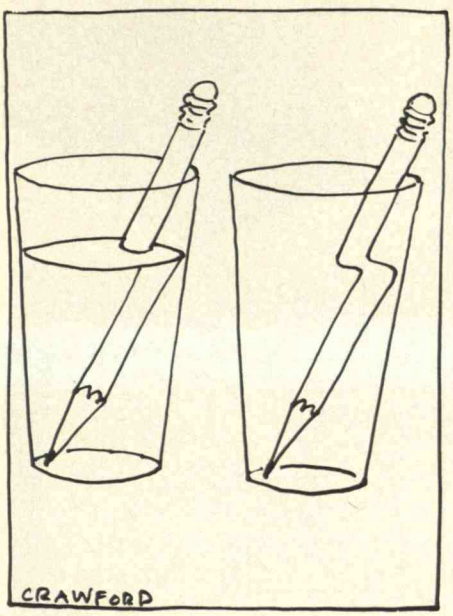
Reviewed by Steven J. Marcus

One of the refreshing things about journalism is its direct, no-nonsense character. Writers and editors either deliver the goods or they don't, and the results are right there in black and white (or living color) for the world to see.

Thus there's little room for posturing or elitism. It is usually not critical, for example, whether a reporter is a high-school dropout or has a Ph.D. If he or she can spot a good story, follow it up with solid research, and write in a reasonably clear and concise manner (especially under deadline pressure), then that person is accepted by other reporters as an equal. And egalitarian treatment comes from above as well: whether you're a veteran or fresh out of school, whether your beat is the White House or town hall, you'll have basically the same perceptions about the depth and sensitivity of your editors.

But in every barnyard there are a few critters who think they are slightly more equal than others. That delusion can affect anyone, of course, but journalists who cover science are especially vulnerable. Given the complexity of their topics, their regular association with some of the research world's leading lights, and their frequent need to "educate" their readers on unfamiliar concepts, science writers can easily come to believe that their skills are more highly developed than those of other writers, and that their problems are unique.

Scientists and Journalists: Reporting Science as News, a collection of essays edited by Sharon M. Friedman, Sharon Dunwoody, and Carol L. Rogers, is a monument to that delusion even though it is put together with thoroughness and sincerity. The book, based on symposia at the 1982 annual meeting of the American Association for the Advancement of Science (AAAS) and complemented by additional materials, concerns the interactions between science journalists and their scientist sources. However, it fails to demonstrate why such a "symbiosis," as the volume's editors put it,



should be fundamentally different from the relationship between other journalists and their sources.

The book does have significant value if you're interested in knowing how journalists—science writers and all others—do their work. For example, it describes how newspaper reporters must locate credible and communicative sources, squeeze big stories into small spaces, maintain balance, and achieve accuracy—all usually within a few hours—while trying to find time for more analytical, feature-length pieces. One can see why they often refer to their product as "the daily miracle."

Einstein vs. the Texas Tax Code

The book is also valuable as a guide for the scientist/technologist, or any other expert, in dealing with the media; it even provides an explicit "how-to" appendix. But the authors' extensive arguments that scientists are somehow different from other kinds of sources—that their mistrust of the media is more acute, that their priorities are narrower than those of other professionals, and that the information they convey requires a different kind of handling—do not ring any truer than the notion that being a science writer, as opposed to simply being a writer, is a special calling.

The only counterargument is found in the chapter on "Scientists and the Local Press," by David W. Crisp. In this graceful essay, Crisp tells us that "dealing with scientists can often be a pleasure, for they tend to be intelligent, articulate, and dedicated to their work. . . . [And] good scientists and good journalists also have a great deal in common: an ingrained skepticism toward established dogma, an eye for accuracy and detail, the ability to deal impartially with facts that don't fit the theory, and contempt for the pernicious notion that all passionately held ideas are of equal value."

As for the premise that writing about science is more difficult than covering other beats, Crisp (a Texas-based journalist) asserts: "Unlike many subjects reporters cover, science writing actually comes easy once the basic principles are grasped and the vocabulary is mastered, because science is comparatively logical, orderly, and precise. The study of long-term radiation effects holds no terror for someone who has tackled the Texas Property Tax Code, and I would rather debate relativity with Einstein himself than try to explain Texas politics."

I have two further problems with this book. One of them—its emergence in a year when science magazines are dropping like flies—is no fault of the editors. But it's ironic that the book's sponsor, AAAS (this volume is part of the association's Issues in Science and Technology series), recently consigned its award-winning magazine, *Science 86*, to the trash heap when the financial going got rough.

It's clear that a nonprofit organization such as AAAS can have difficulty playing by the hardball rules of the publishing industry, especially in having to invest gargantuan sums under chronically high-risk conditions. What is less clear is why AAAS couldn't have tried a little harder and a little longer to find a sympathetic buyer. Given its apparent haste in selling *Science 86* to Time, Inc. (which had already announced it would simply kill the magazine in favor of its own *Discover*), observers began to question whether such organizations really believe their own high-sounding rhetoric about improving the scientific and technological literacy of the general public.

My second problem is very much the fault of the book's editors, as well as of many other journalists who call themselves science writers. It's the contradiction, both in the book and in the world of

ILLUSTRATIONS: MICHAEL CRAWFORD

The military has both stimulated technological development and distorted the allocation of economic resources.

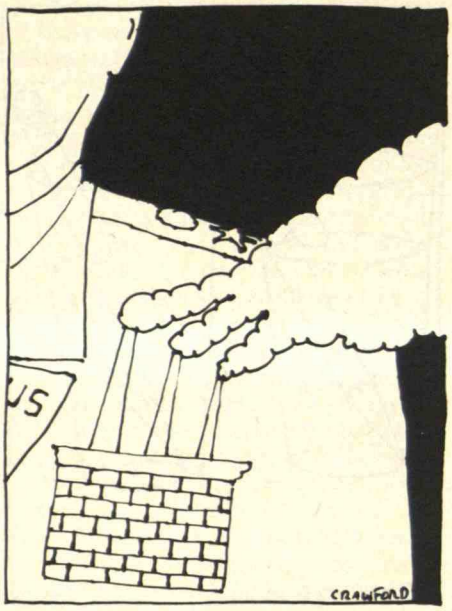
science journalism that it analyzes, of defining "science" to include technology and related areas of "societal impact" while nevertheless continuing to deal mostly with black holes and quarks. Thus science writers shouldn't groan too loudly when their esoteric and gee-whiz stories are rejected or condensed, and they shouldn't be resentful when others jump into the breach to report on timely developments of practical importance.

STEVEN J. MARCUS, executive editor of High Technology, *was formerly technology reporter for the* New York Times *and managing editor of* Technology Review.

How the Military Affects Civilian Technology

Military Enterprise and Technological Change
Edited by Merritt Roe Smith
M.I.T. Press, $30

Reviewed by Daniel J. Kevles



Even the most casual newspaper reader knows that the military is closely linked to industry as both a major sponsor of technological innovation and a primary customer for its products. Since the late 1970s, the budget for the Department of Defense has more than doubled, to almost $300 billion, and the DOD share of federal expenditures for R&D has risen from about 50 percent to 70 percent. So much money is bound to affect profoundly the course of the nation's research, technological progress, and industrial development. The budgetary changes have thus stimulated considerable debate about the likely short-term and long-term social and economic consequences. Will immense investments in Star Wars, for example, shortchange the civilian economy? Will the drive to enhance national security diminish the social freedoms that it is supposed to protect?

Unlike most policy debates, these disputes have been marked by few appeals to past experience, not least because historians have given surprisingly little attention to the domestic impact of "military enterprise"—that is, the armed forces' promotion, coordination, and direction of technological change. That enterprise has helped produce a remarkable array of technologies, ranging from mechanized production in the nineteenth century to computers, sonar, jet engines, numerically controlled machine tools, and nuclear power in the twentieth. Yet as Merritt Roe Smith, a historian of technology at M.I.T. and the editor of *Military Enterprise and Technological Change,* rightly says, the subject of military enterprise "remains one of the least understood and appreciated phenomena in American culture. . . . Quite apart from the serious moral liabilities taken on by militarized societies, the questions remain: Has the influence of the military on civilian industrial development been a good thing? Is military enterprise an effective way of generating new technologies? Has society benefited?"

The nine contributors to this volume attempt to address these questions mainly through case studies. This is not a moral tract against military enterprise: the authors show that the military has both stimulated technological development and distorted the allocation of resources in the national economy. For example, the services have long been an effective force in propelling the evolution of American manufacturing. In the pre-Civil War era, Smith shows, the army imposed an enormous degree of uniformity on the arms industry's procedures for development, testing, and production, shouldering it away from craft to systematized, mechanical manufacturing methods. Charles F. O'Connell, Jr., further shows how during this period the Army Corps of Engineers provided a model for business in establishing the complex bureaucratic management procedures of large-scale enterprise.

However, the military has sometimes—and wisely—been more conservative than industry in the manufacturing methods that it has favored. Conventional wisdom has it that during World War I, Henry Ford proved to the navy that he could use the mass-production techniques he had pioneered to turn out a new submarine chaser—the Eagle—efficiently and successfully. Yet David Hounshell demonstrates that the Eagles were produced slowly, tended to leak, and lacked a certain sea-worthiness. Assembly-line riveting of flat hull plates did not yield as high quality a product as the carefully crafted joining of rolled hull plates that was integral to the navy's tradition of ship design and manufacture. Only Navy Secretary Josephus Daniels' enthusiasm for Ford's promises of miraculous manufacturing rates kept the Eagle program going.

Of course, military enterprise has not always been clear-headed and decisive. Challenging the prevailing view, Susan J. Douglas maintains that the navy took a mossbacked attitude toward the possibility of using radio waves for communications before World War I. In particular, the service exacerbated the financial risks of would-be suppliers by imposing severe test and performance requirements on the wireless equipment being developed.

Skewing Civilian Efforts

Several authors also argue that civilian spinoffs from military technology have often been gained at high cost to the national economy and the social corpus. Thomas J. Misa contends that although the Army Signal Corps accelerated the emergence of the transistor industry in the 1950s, the corps also skewed Bell Laboratories' pioneering efforts away from civilian applications. Because the corps required "transistors that could withstand high temperatures and amplify high-frequency signals," it fostered the development of devices that were often inappropriate to the commercial telephone system for which Bell had made its original investment. The military work on

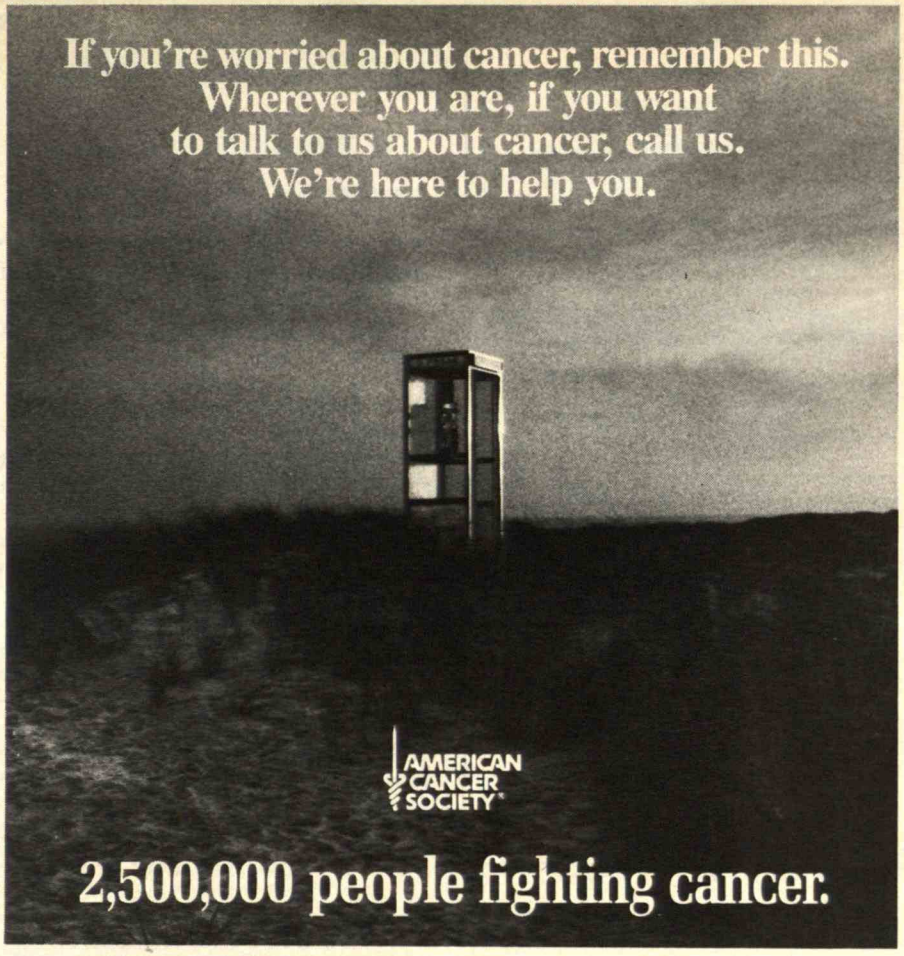
transistors also drained technical personnel—decidedly scarce in this field during the 1950s—away from commercial work.

David Noble elaborates on these effects, maintaining that the technology the military enterprise has forged has done little to meet the ordinary needs of civilians. He adds that the military also helped dehumanize the workplace by encouraging companies to use numerical controls in manufacturing processes requiring complex machining. The idea was to obtain uniformity and exactitude in high-performance parts by feeding mathematical information directly into a machine, rather than by relying on the skills and initiatives of machinists. This meant that factory workers had to tailor their work practices to fit the efficiencies of their machines instead of functioning as independent craftspeople.

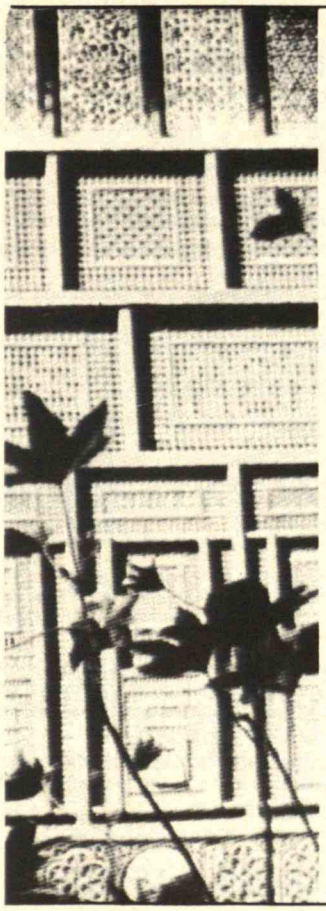
Peter Buck examines the role of the social sciences in serving the military during World War II—an important initiative considering that the military's patronage of the social sciences has since been vast. During the war, under the auspices of the War Department, sociologists, anthropologists, and psychologists worried about how to evaluate men and women recruited for the Office of Strategic Services, scrutinized Japanese and Japanese-Americans in order to forge strategies of psychological warfare, and endlessly studied the American soldier, pondering how to keep him happy and committed to his task. Buck argues that this experience affected the research agenda in several fields of social science—redirecting it from a concern with the impact of technological change upon society to an absorption with how society's attitudes might be manipulated into comfortable adjustment with the threats and intrusions of a technologically dangerous world.

These well-written essays add up to an important, pioneering volume. By suggesting that U.S. military enterprise has been a mixed economic and human blessing, they lead us to question the continuing U.S. propensity for relying on the military as the government's principal agent of technological innovation.

DANIEL J. KEVLES is professor of history at the California Institute of Technology and author of The Physicists *(Knopf, 1978) and* In the Name of Eugenics *(Knopf, 1985).*



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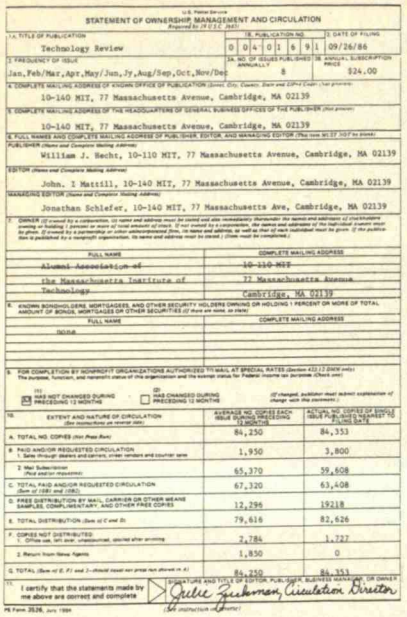
Principles and Examples with Reference to Hot Arid Climates

Hassan Fathy

Hassan Fathy, who has taught and worked extensively in the Middle East, argues that traditional buildings in hot arid climates are based on considerations of comfort and beauty, social and physical needs. The use of modern design and materials in such places can destroy this harmony. In his view, local materials and traditional methods, combined with improved use of natural energy, can solve many of the problems facing contemporary architecture, in particular, the Third World housing situation.

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LETTERS

CONTINUED FROM PAGE 4

objective and informative accounts of their work. The general public could demonstrate its own good faith by reading those accounts.

NEW FUNDS FOR SCIENCE

In "Is U.S. Science Slipping from First Place?" (*May/June, page 24*), Daniel Kleppner correctly states that when responsibility for basic research shifted from the Department of Defense (DOD) to other agencies, the result was unfortunate.

But support was not completely lost. National Science Foundation (NSF) funds were increased by about $60 million to $80 million a year specifically to compensate for the loss of DOD funds. The increase for materials research was equal to more than half the previous rate of DOD support.

EDWARD P. TODD
Falls Church, Va.

OXYGEN SHOTS FOR RIVERS

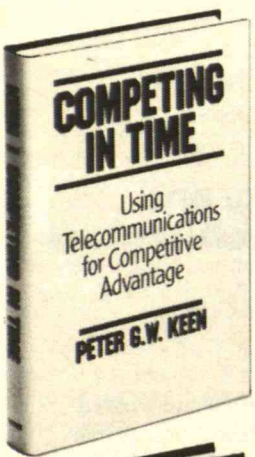
I liked Tony Davis's article "Managing to Keep Rivers Wild" (*May/June, page 26*). Mr. Davis might be interested in the technology of the new Richard B. Russell Reservoir on the Savannah River in Georgia. Every day 150 tons of gaseous oxygen are injected into the deep waters of the reservoir. This protects water quality downstream when deep waters are oxygen deficient. Thus wildlife is preserved.

CHARLES H. CABAN
Atlanta, Ga.

ELOQUENT COVER

The cover of the May/June issue, which illustrates the article on verifying arms treaties, tells a good deal in very few words. I am sending copies to my senators and congressman.

HENRY N. ANDREWS
Laconia, N.H.



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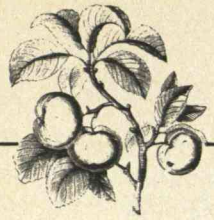
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HERBICIDES

CONTINUED FROM P. 61



herbicides may also be imposed in the next two to four years. The EPA will no doubt need more data before decisions can be made. It is particularly important that the EPA's long-awaited groundwater-monitoring survey—which is expected to end in 1987—be completed with dispatch and great attention to detail.

Many older herbicides pose some carcinogenic risks. It appears that none is a potent carcinogen like the pesticide ethylene dibromide (EDB), which has now been banned, but it is very hard to estimate how great the human cancer risks are. Because of the wide use of carcinogenic herbicides, the EPA should find more compelling ways to convince farmers to comply with the safety precautions on herbicide labels. Herbicide spraying systems should also be changed to better protect agricultural workers, as should the packages and formulations in which the herbicides are sold. For example, the EPA could require that concentrated herbicides be packaged in containers that dissolve in water, so farmers don't run the risk of touching the chemicals. Or since farmers often apply two or more herbicides, the EPA could encourage the mixing of compounds at manufacturing plants.

And as they reassess these products, regulatory agencies should remember that many substitutes are available, and should consider the availability of new products.

Regulatory agencies may eventually recognize the size of the environmental gains from using the newer herbicides. The newer herbicides are generally applied at one-half to one-tenth the rates of the older products. Despite rigorous testing, they have not demonstrated mammalian toxicity, and they have little or no potential for migrating into groundwater. Also, they almost certainly will not raise farmers' production costs.

It is heartening that about three-quarters of the corporate R&D in herbicide resistance is targeted toward the newer compounds. The environment would benefit if research succeeds in broadening the uses of the highly active, newer herbicides. The question remains whether regulators and corporate financiers will have the vision to fully exploit this potential. □

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Running Out of Oceanographers?

The demand for oceanographers is beginning to exceed the supply, the number of students entering graduate study remains constant, and too many potential applicants are opting for the glitz of computers, automation, and artificial intelligence. "Serious shortages" stemming from an "explosion" of oceanographic technology are forecast in *Sea Technology* magazine by Professor Arthur R. M. Nowell of the University of Washington, Charles D. Hollister of Woods Hole Oceanographic Institution, and Arthur N. Baggeroer of M.I.T.

Here is how supply and demand balance in the five subfields of oceanography, according to the oceanographers, who reviewed data assembled by the major teaching and research centers that are members of Joint Oceanographic Institutions, Inc.:

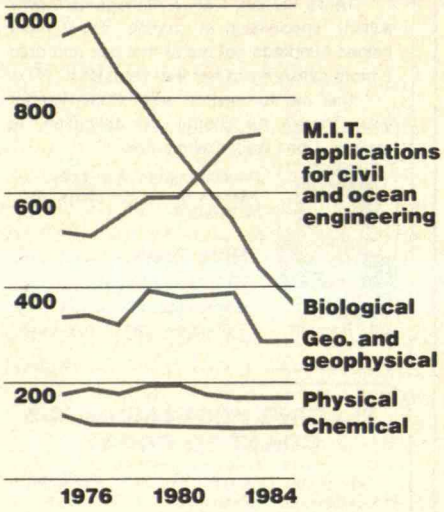
☐ Biological oceanography—the science of life in the oceans and related systems. Research opportunities abound, thanks to increasing human exploitation of the ocean and new tools such as laser-based counters and satellite-borne sensors. The number of applicants for graduate study in this field has dropped by 70 percent in the last decade, and if the trend continues there will be empty places for students in the leading schools by the 1990s.

☐ Geological and geophysical oceanography. The number of students has gone up by 10 percent during the past decade, but the applicant pool is now shrinking. Meanwhile, there is lively demand, especially for graduates trained in technologies such as seismology and remote sensing.

☐ Physical oceanography—the physical behavior of the ocean and its effects on air and land. The number of applicants is down, and the pool of graduates in the next decade will be very small. "We foresee a serious shortage of physical oceanographers," write the educators.

☐ Chemical oceanography—the chemistry of sea water and its pollutants. There is growing interest in the effects of wastes and in the oceans' role in storing essential elements such as carbon dioxide, and demand for marine chemists "is sure to increase," write the educators. Yet enrollment has remained virtually unchanged for a decade.

☐ Ocean engineering—the special problems of engineering in the marine environment. There is lively interest in the hydrodynamics of ships, platforms, and moorings, acoustic propagation, sonar, submersibles, and instrumentation; these technologies are growing more and more complex; and the demand is increasing. Enrollments are increasing, too—but not as fast as in other engineering fields where opportunities in fact may be fewer. ☐



Applications to enter graduate study in oceanography and ocean engineering have failed to keep pace with the increasing demand for graduates, say three oceanography teachers/researchers. The result, they fear, will be "serious shortages" in the future. (Applications for ocean and civil engineering at M.I.T. suggest the rising interest in ocean technology; much M.I.T. civil engineering research is ocean-related.)

Toward Stronger Ceramics

A new method of forming silicon nitride, a ceramic that is corrosion-resistant, chemically inert, lightweight, and strong at high temperatures, promises to improve the usefulness of that unique material.

In the normal process of manufacturing silicon nitride parts, a shape formed in silicon powder is exposed to a high-temperature gas enriched with nitrogen. The silicon reacts with the nitrogen so the powder becomes a solid. But the result, while stronger than silicon nitride made by other processes, lacks strength at temperatures above 1,200° C.

Now a team in the M.I.T. Energy Laboratory has discovered how to improve the process: use tiny uniform-sized beads of very pure silicon. These beads pack tightly together without the "voids" that cause the internal flaws that lead to structural failures in conventional ceramics. Senior research scientist John Haggerty believes the new method may also permit carbide fibers to be incorporated into the ceramic—a long-sought goal to increase its high-temperature strength. Already the new process promises to simplify the production of silicon nitride: the conventional nitriding cycle can require several days at temperatures of at least 1,400° C, while the M.I.T. method requires only three to seven hours at somewhat lower temperatures. ☐

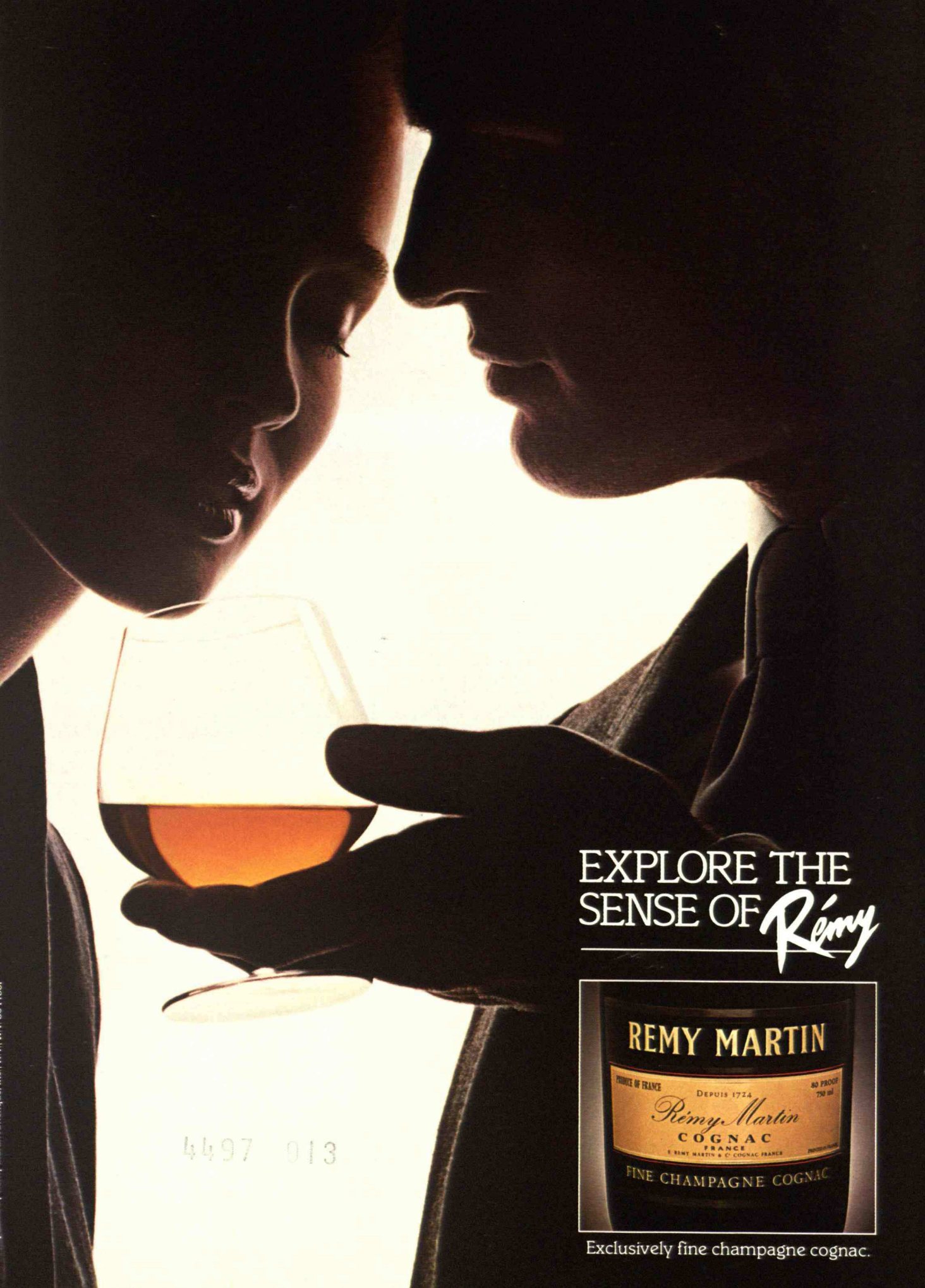
New Uses for Extreme Cold

A new strategy to increase the sensitivity of a nuclear magnetic resonance (NMR) spectrometer, commonly used to analyze the structure of complex molecules, has been discovered at M.I.T.: operate the machine with its molecular sample at less than 0.01 degree above absolute zero—so cold that the molecules are almost completely immobilized.

At this temperature, say Professor John S. Waugh and his colleagues in the Chemistry Department, NMR can be sensitive enough to unravel some long-standing mysteries: How do surface molecules work to give catalysts their special chemical activity? How do metal atoms play their vital role in enzymes' function?

To cool their samples to this extremely low temperature, the M.I.T. team uses a rare helium isotope—helium-3—in its liquified state as the refrigerant. To be cooled uniformly, the samples must have a large ratio of surface area to volume. That's easy in the case of materials that can be finely powdered—including enzymes, where Waugh's group is trying to create powders in which each particle will consist of a single molecule. New methods for conducting cold will have to be devised for other materials. ☐

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